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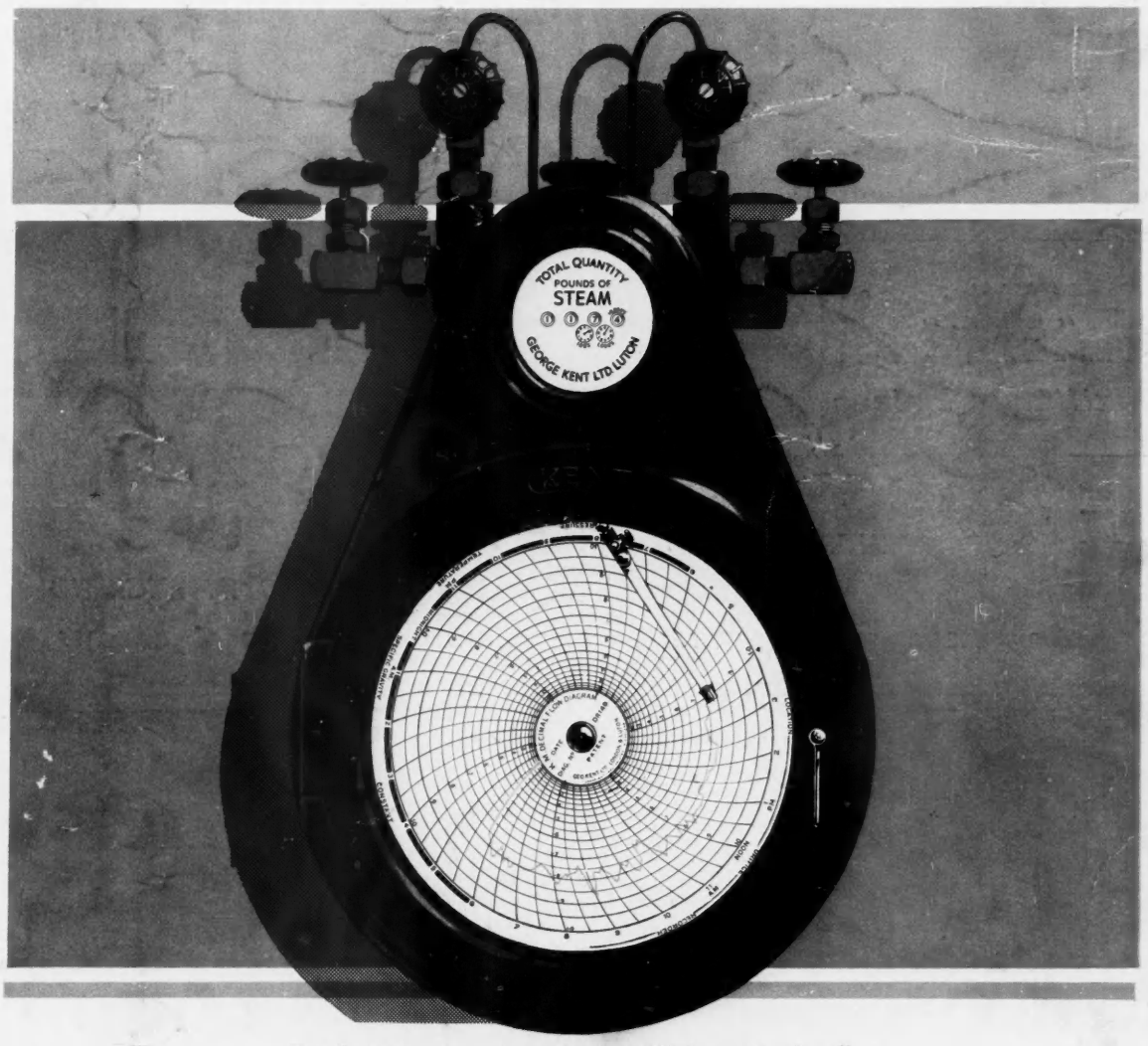

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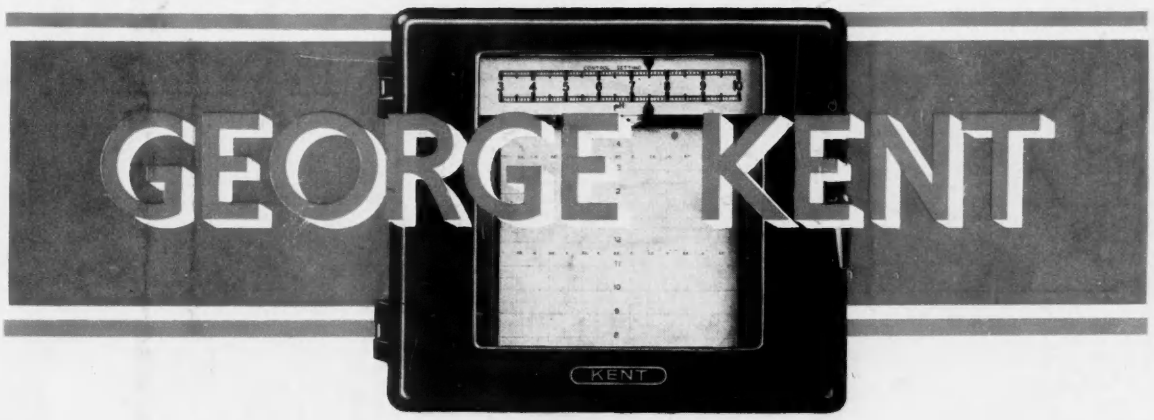

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JULY 5, 1940—VOL. CLXX

THE ENGINEER

A Seven-Day Journal

The Replacement of Shipping

AT the annual general meeting of the Royal Mail Lines, Ltd., which was held in London on Friday, June 28th, the Right Hon. Lord Essendon, the chairman of the company, made reference to the problems connected with ship replacement. Early in the year, he said, the Ministry of Shipping decided to apply a policy of general requisition of ocean liner fleets. Since the announcement of that policy the different sections of the shipping industry had been discussing with the Ministry the rates of hire. In the case of liners, with which the company was particularly concerned, the difficulty had been, with so many varying types of vessels and speed, to get a uniform rate that would apply fairly all round. As an alternative, the company decided to apply itself, after agreeing to a rate to cover operating expenses, a method of return on capital employed. The basis ultimately agreed upon was 5 per cent. depreciation and 5 per cent. interest on the original cost of the ship, with certain variations to meet special conditions. The last thing which the shipping industry wished to do, Lord Essendon said, was to make profits out of the war, but it had to be remembered that shipping was in a very special condition. The average life of ships in the company's service was about twenty years, and in each of these years it was the endeavour of the company to provide out of its earnings 5 per cent. towards the ultimate replacement of the ship, so that at the end of the life of the vessel there would be a fund with which to build a new ship. If such a ship originally cost, for example, £100,000, a reserve of approximately £4000 per annum, accumulating at 3 per cent. interest, would provide for the building of a new ship, if building prices remained stationary. But if at the end of the life of the ship prices had so risen that the new ship cost £200,000 instead of £100,000, then the ordinary standard achieved only half its purpose. It had been suggested to the Government that it should allow an additional percentage which should not be paid to the owners, but should be held by the Government to the owner's credit for replacement after the war. If the money was not so utilised, then it would remain in the hands of the Government. Such a plan seemed both reasonable and desirable, as it would avoid subsidising and delay. The Government had, however, decided that replacement must be regarded as a post-war measure. It had, however, placed on record its sense of the importance of the mercantile marine, and the necessity of its maintenance and development.

Staff Alterations in the Ministry of Supply

IN an address given in the House of Commons on Thursday, June 27th, Mr. Herbert Morrison, the Minister of Supply, passed in review the alterations to staff which had, he said, recently taken place in the Ministry. Sir George Gater, who had a very rich administrative experience, had been appointed joint secretary to act with Sir Arthur Robinson. Sir Walter Layton had been appointed Director-General of Programmes, and would have associated with him the Director-General of Statistics. The office of Director-General of Munitions Production under Engineer Vice-Admiral Sir Harold Brown covered too wide a field for one man to handle, and Mr. Alexander S. Maclellan had been appointed Director-General of Ammunition Production, and Mr. Davidson Pratt Deputy Director-General of Chemical Defence. Another appointment had been that of Mr. S. C. Leslie as Director of Public Relations. His work, the Minister stated, would not be ordinary publicity work in the ordinary way, but would deal with problems of *morale* within the industrial organisation, and relations with the public in regard to such questions as salvage. Mr. Geoffrey Crowther had been brought in as Director of Programmes under Sir Walter Layton. In the Tank Division Mr. Peter F. Bennett, who had done very good work, had tendered his resignation, which had been accepted, and Mr. Geoffrey D. Burton, a very good production engineer, had been appointed as Director of Tanks and Transport. In the Department of Machine Tools Mr. Arthur A. Rowse had been replaced by Mr. Percy Mills as Controller of Machine Tools, and had under him as Deputy Controller Mr. J. C. Blair, who also had a very considerable and intimate experience with machine tool problems. Extra junior staff had been appointed. Should there be any slackness or inefficiency in any way inside or outside the Ministry, Mr. Morrison assured the House that he would not hesitate to use the powers which had been conferred upon him. The task, he said, was to make the transition from something like passive to active planning. With each real change in the military situation he had given instructions that the programme should be looked at again and, if need be, strengthened again in the light of the new circumstances.

John Brown and Co., Ltd.

IN the course of his address at the annual general meeting of John Brown and Co., Ltd., which was held in London on Friday, June 28th, the Right Hon. Lord Aberconway, the chairman of the company, said that during the year the greater part of the expenditure on capital account had been incurred in the further improvement of the equipment of the shipyard and engine works at Clydebank. During the past five years, he continued, the sum of over £200,000 had been spent upon the installation of modern machine tools and equipment, and a very greatly increased turnover at the shipyard had been made possible by such modernisation. Without it the firm's production would have been seriously limited, and by its use it had been possible to produce, economically and rapidly, many detailed parts which would otherwise have only been obtainable with difficulty and delay. Although no reference could be made to the Government contracts, reference must be made to the highly creditable progress made during the year in the construction and completion of the liner "Queen Elizabeth," built to the order of Cunard White Star, Ltd., which had made possible that vessel's departure from the Clydebank basin on the original contract date, namely, at the end of February. No greater tribute could be paid to the skill and workmanship at Clydebank than the fact that, entirely without the usual preliminary trials, the liner had made the voyage from the Firth of Clyde to New York without delay or mishap of any nature. Lord Aberconway added that during a substantial part of the voyage the ship was driven at her normal speed. It is of interest to recall that July 4th marked the centenary of the first Cunarder, the "Britannia," which on Friday, July 4th, 1840, sailed from Liverpool to Nova Scotia, on the first Cunard Atlantic mail service. The "Britannia" was one of the four paddle steamers of the original Cunard fleet, and she had a length of 207ft. and a tonnage of 1154. Her Napier side-lever engines had an output of 740 I.H.P. and gave her an average speed of 8½ knots on a coal consumption of 38 tons per day. Since that day many famous Cunarders have sailed the Atlantic. The two latest ships are the "Queen Mary" and the "Queen Elizabeth," both designed and built at Clydebank. They have a gross tonnage of over 80,000, and geared turbine machinery of over 180,000 S.H.P., and are capable of a speed of over 29½ knots.

A Man-Power Survey

ON Friday, June 28th, Sir William Beveridge, the President of the Royal Economic Society, in a broadcast address announced that he had been asked by Mr. Ernest Bevin, the Minister of Labour and National Service, to survey the available man-power resources of all kinds, and to make any suggestions that might arise out of the survey, as to how those resources could be utilised fully for national purposes. With the help of a large and growing Department, the Minister of Labour is now hard at work mobilising our labour forces, transferring men and women from unessential to essential jobs, training them, stopping unnecessary transfers, avoiding unnecessary disputes, seeing to industrial welfare, and trying in every way to meet the inexhaustible demand for special classes of labour. While not himself having any executive power, Sir William said that his task would be to examine the problem from a particular end by seeing just what resources of man power and of what kinds were available, why those resources were not yet being fully used, and what steps might be taken to get them more fully used. Continuing, Sir William went on to say that the most important lesson that all employers should be asked to lay to heart now was that they would probably not be able to get employees of just the skill and experience, which they most liked to have, and which they probably got in peace time. In war employers would have to learn to do with substitute labour. They would have to take women or young people in place of men, older men and women than they were used to, and people who did not know the job and had to be taught it. That applied to employers of all kinds, farmers, industrial and commercial firms, and the Government itself. War was an affair of substitutes, both in goods and labour. His, Sir William's, problem was to find out what sort of substitutes were available for the skilled labour that could not be provided, and how those substitutes could best be fitted into the national need. The Deputy Director of Statistics in the Ministry of Labour, Mr. A. Reeder, has been appointed by the Minister to act as Secretary to the Man-Power Survey.

The Anderson Steel Shelter

LAST week it was made known that the designer of the Anderson steel shelter, which in the air raids of the past two weeks or so has proved its value on many occasions, is Mr. William Paterson, M.I. Mech. E., the chairman and managing director of the Paterson Engineering Company, Ltd., of Windsor House, Kingsway, London, W.C.2. It may be recalled that when Sir John Anderson was appointed Minister of Defence in 1938 one of his immediate tasks was the consideration of a shelter policy. He decided in favour of a plan for taking protection to the people, by providing portable shelters, which could be erected in their own gardens. Having made this decision, Sir John submitted the technical problem to his friend, Mr. William Paterson, who produced a design which he patented. He later presented the patent to the nation as a free gift. Sir John Anderson referred the design to the President of the Institution of Civil Engineers, who at his request nominated a panel of three eminent engineers, who gave their opinion on the design which was proposed. These three engineers were Mr. David Anderson, Mr. Bertram Lawrence Hurst, and the late Sir Henry Japp. In December, 1938, their report was submitted to Parliament, and was published as a White Paper the same month. With certain modifications, which were introduced in order to make the mass production of the shelter easier, the experts adopted Mr. Paterson's design in its entirety. Thus it was that the Anderson steel shelter was brought from the design stage into active production.

The Royal Aeronautical Society

IT is announced by the Royal Aeronautical Society that Mr. Griffith Brewer, Hon. F.R.Ae.S., has been elected President of the Society for the year 1940–41, and that Lieut.-Colonel J. T. C. Moore-Brabazon and Professor L. Bairstow have been elected Vice-Presidents for the same period. Mr. Griffith Brewer was born in London in 1867, and commenced ballooning in 1891. On the formation of the Royal Aero Club he took his Aeronaut's Certificate No. 5. He represented Great Britain in four Gordon Bennett balloon races, in Paris 1906, St. Louis 1907, Berlin 1908, and Geneva 1922, and in 1908 won the International Balloon Competition in England. When Wilbur Wright came to France in 1908 Mr. Brewer was his first English passenger, and thus became the first Englishman to go up in an aeroplane. From then on he devoted his attention to aeroplanes and in 1914 learnt to fly at the Wright Field at Dayton, Ohio. During the Great War he was Hon. Adviser to the Airship and Kite Balloon Services at Roehampton from 1915 to 1918, and made experiments with ripping kite balloons in the air after breaking of the cable for the R.N.A.S. in 1917–18. In 1912 he founded the Wilbur Wright Memorial Lecture. More recently, in 1938, he has delivered addresses at Dearborn and in 1938 at Massachusetts Institute of Technology on the Wright Brothers Scientific Research. He piloted his own Moth aeroplane from 1930 to 1938. Since the outbreak of war the Air League has reprinted his Roehampton lectures on kite balloons for use of the balloon barrage personnel, there being no other text-book available. It was largely due to Mr. Brewer's efforts that Mr. Orville Wright has lent his original aeroplane, on which the first power flights were made at Kitty Hawk, North Carolina, to the Science Museum, South Kensington, where it has been for the past twelve years.

GOVERNMENT TRAINING CENTRE AT LEEDS

(For description see opposite page)

FIG. 1—MACHINE SHOP

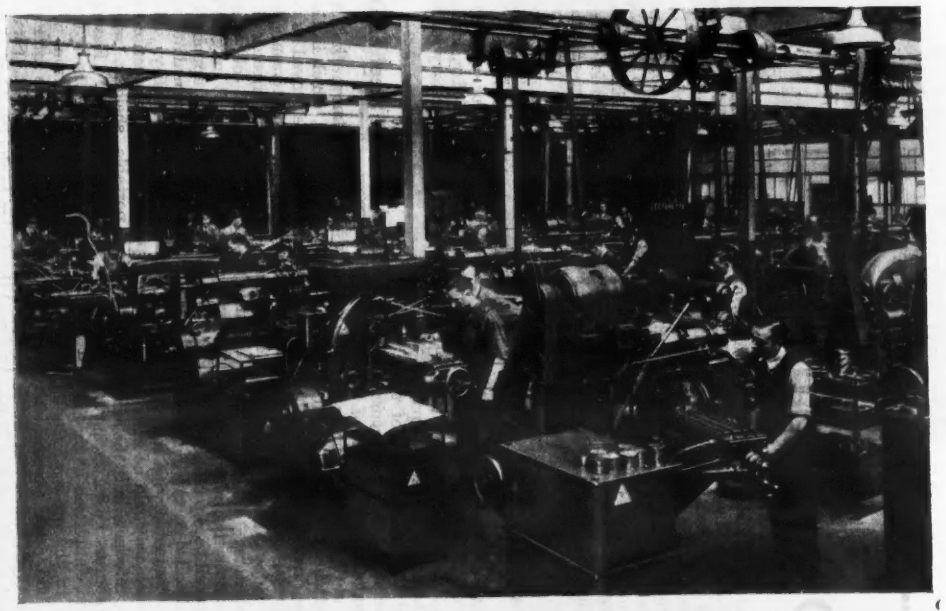


FIG. 2—MACHINE SHOP

FIG. 3—FITTERS' SECTION

FIG. 4—SHEET METAL SHOP

Government Training Centres

No. III

(*Continued from page 471, May 24th*)

THE LEEDS TRAINING CENTRE

THE Centre at Leeds, which was established by the Ministry of Labour some two years ago, is situated on the site of an old shoe factory, the large single-storey main building of which was well suited for the laying down of plant for training purposes. The organisation and arrangement of the Centre has been from the first in the hands of the present Manager, Mr. G. W. Green, who has with obvious success adapted the training methods to suit the class of work done in the North-Eastern Division of the country with which the Centre is particularly concerned.

Men, when they enter the Centre, are given the usual educational course of arithmetic, as applied to workshop practice, during their early weeks of training. From the time he enters the Centre each man keeps two notebooks; one is used for making rough notes in the shops and at lectures, and the other comprises a record of practical theory upon which the work carried out is based, and details of the work done. This second, or "finish," book, as it is known, is prepared by the men in their own time and is brought up to the Centre each week for inspection. We had an opportunity of seeing a number of these books, and it must be a matter of considerable gratification to the training staff to see the interest which most of the trainees take in their work and the trouble taken in the compilation of the notes. These indicate a pleasing keenness which is reflected in the more important practical side of the training.

At monthly intervals every trainee has to undergo a practical test, in which he does one of a specified number of jobs and has an oral examination, based upon his notebook, to ascertain that he fully comprehends the theoretical side of his work. On the actual workpiece marks are based upon the time taken, quality, accuracy, execution, and neatness; in the oral examination marks are awarded on knowledge of the trade, signs of initiative, notebook arrangement, and what is termed "placing impression." This "placing impression" takes into consideration a man's appearance, attitude, and general personal attributes likely to prove advantageous or detrimental in an interview to secure a job. The preponderance of markings is, of course, allocated to the practical side. When a man fails to obtain a certain percentage of marks in a test he is given a second similar test, the object of which is to ascertain if his first failure was caused by temporary nervousness or some similar unimportant lapse. If, however, the man fails on the second test he is interviewed by an executive member of the staff in the "Orderly Room," described in our previous article, and the cause of his inability to qualify ascertained, and, if possible, rectified or disciplinary measures are taken. These tests are always carried out by the Chief or Assistant Chief Instructor in the absence of the Class Instructor. In their inspection of the workpieces, after the completion of the tests, they are assisted by advanced trainees from the tool room and drawing-office. In this way the advanced trainees selected are not only given good practice at inspection work and the use of precision instruments in a small inspection room, but also learn the pitfalls commonly encountered in engineering work.

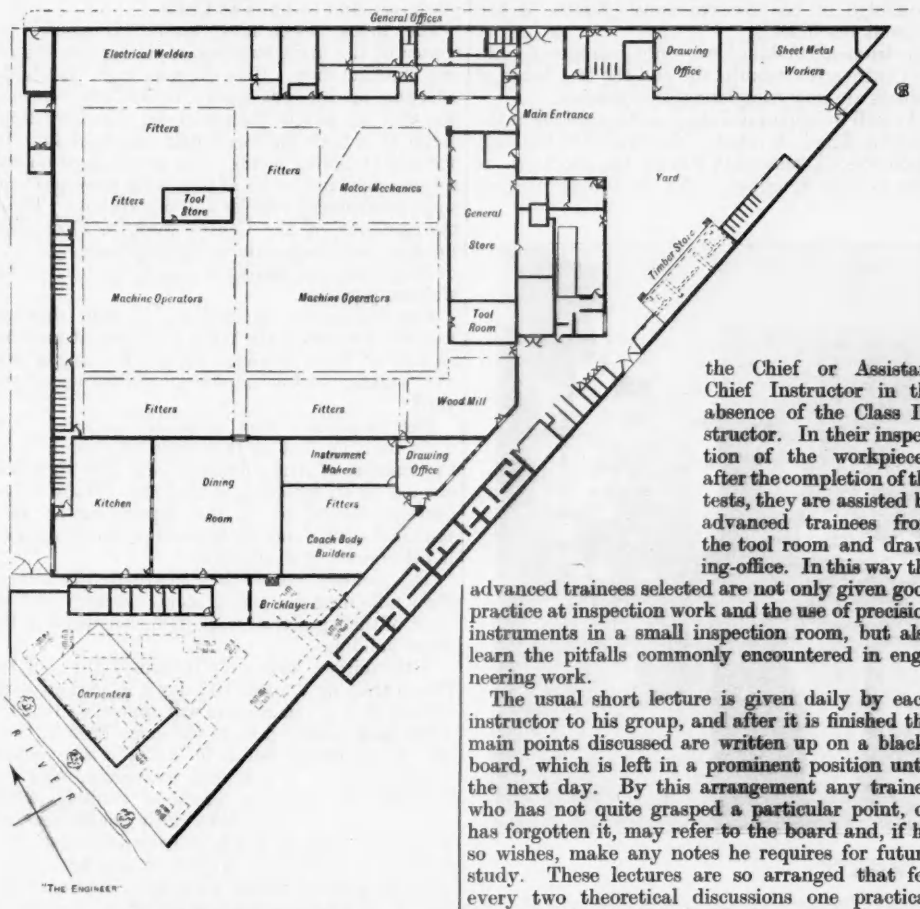


FIG. 5—PLAN OF CENTRE

The usual short lecture is given daily by each instructor to his group, and after it is finished the main points discussed are written up on a blackboard, which is left in a prominent position until the next day. By this arrangement any trainee who has not quite grasped a particular point, or has forgotten it, may refer to the board and, if he so wishes, make any notes he requires for future study. These lectures are so arranged that for every two theoretical discussions one practical demonstration is given by the instructor. Most of the trainees upon entering the Centre have special bins allotted to them in the inspection department, and all of the test pieces made during the courses are numbered and kept in these bins. This collection of test pieces is of particular value to the Placing Officer of the Centre when he has to select a man for a particular class of work specified by a prospective employer. In each of these tests a time is specified for their completion, but no actual account of working speed is seriously considered during normal training until the completion of about twenty weeks' training. After this, and until the completion of the course, each man carries out his work under similar time conditions to those laid down in an ordinary workshop.

LAY-OUT OF THE CENTRE

In the accompanying plan of the Centre it will be seen that the administrative offices and most of the training departments are contained within one large single-storey building. Smaller adjoining buildings accommodate the draughtsmen, painters, carpenters, sheet metal workers, timber store, &c., and a large area of the main yard is used by the bricklayers for their exercises. At present a wet weather shelter is under construction for the bricklayers and a number of other structures are being built adjoining the hardening shops. The timber store in the main yard was recently rebuilt and a large shelter constructed below.

DRAUGHTSMEN

Every draughtsman, before he begins his training at the board, first completes a short course of practical work in each of the other sections in the Centre. The knowledge of the various processes and tools acquired in this manner is supplemented in several ways during the actual course of draughtsmanship. There is no moulding or patternmaking done at the Centre and the men would normally only acquire knowledge of this important class of work from lectures and text-books. This was not considered by Mr. Green to be a particularly satisfactory method of teaching about castings and patterns, so he has arranged visits to a number of works in the area, where the trainees can see this class of work actually being done under factory conditions. As stated previously, these men also assist in the inspection of work done by other trainees and they acquire a good working knowledge of the strength of materials in the testing of work done by the welders. After preliminary training in practical draughtsmanship the men rapidly pass on to design work. For this they take the drawings of tools and machine parts made in the earlier stages of training and design drilling and machining jigs suitable for their production. In another stage of training the men are given catalogue drawings of such things as gear-boxes, reduction gears, &c., and from them design similar arrangements for different capacities, incorporating in the design standard parts, such as ball bearings, bolts, &c. The men are encouraged to use their own initiative when engaged in this design work, to embody their own ideas, and to suggest improvements.

WELDERS

A particularly comprehensive scheme for the training of both electric and oxy-acetylene welders has been laid down. The men in this section not only learn to use a wide range of machines, but, by a series of ingenious arrangements, are required to work under varying conditions. We will deal first with the electric welders who work in a section of the main building adjoining the offices. This section has been divided up into fourteen separate cubicles, and in it are installed nine welding sets, giving six A.C. and nine D.C. points. Some thirty to forty types of standard electrodes, up to $\frac{3}{8}$in.

FIG. 6—INSTRUMENT MAKERS' SHOP

diameter, are used, and the training covers the welding of various types of metals down to 26-gauge. Each of the cubicles is arranged differently, not only in respect of the type of machine installed, but from the way in which the actual job is done. One cubicle has a bench of standard height, upon which the work is done; another is arranged so that the work is down on the side of the bench and the man has to lie on the floor to do it. Another bench has a rail at waist height projecting from its side so that a man has to reach across in an awkward manner to get to the job. Other benches are high, and it is necessary to reach up or stand on tiptoe to weld, whilst others are proportionately low and have to be crouched over. One cubicle contains a replica of a manhole, through which the trainee has either to lean or lie to get to his work. A cage has been designed in which a man has to half lie to weld partly over his head. A steel framework in one cubicle has been erected so that planks may be set across it in various positions to make the approach to a job awkward and train a man in the arrangement of scaffolding to the best advantage. Out in the yard we saw a fairly high scaffolding, erected by the bricklayers for training exercises, being used by a man working with a D.C. petrol engine-driven portable welding set under typically difficult conditions.

From the above it will be seen that when a trainee has finished his course he has not only had a complete training in how to do a good welding job, but has experienced a wide variety of the conditions under which the work must often be carried out. This method of training is obviously of great value to the men when they start actual work, as not only do they have some knowledge of vertical and overhead welding in addition to the usual downhand work, but they can approach any awkward type of job with confidence and ability. In the adjoining oxy-acetylene welding section both high and low-pressure work on various metals and lead burning are taught. Here again the benches are arranged at varying heights and the methods of approach to work are made difficult. After careful inspection and any necessary criticism all welds, both electric and oxy-acetylene, made by the men are tested in tensile or bend testing machines in the presence of the trainee responsible. Certain test pieces are first welded in the sheet form and are then passed out to the machine shop, where their cutting to shape forms part of a machining exercise. In this way each test piece serves in three distinct phases of training, *i.e.*, welding, machining, and material testing for the draughtsmen.

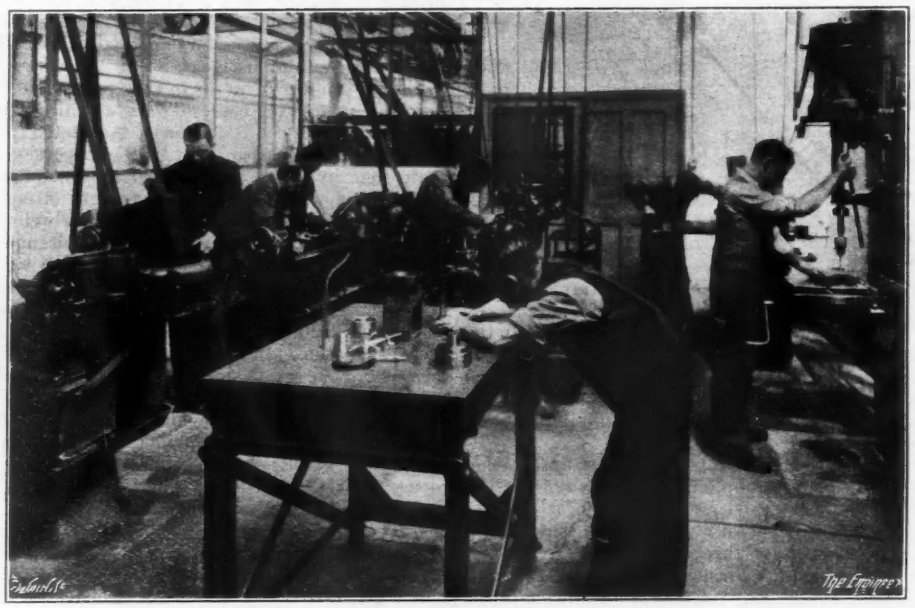


FIG. 7—TOOL ROOM

FITTERS, INSTRUMENT MAKERS AND SHEET METAL WORKERS

A large number of fitters are trained in the section of the main shop, shown in Fig. 3 on page 2, adjoining the welders. Here, as in the other Centres, the men progress from group to group under different instructors for the first period of their training. When, after about twelve weeks, they have reached a certain standard in general work, they pass on into separate sections for final training as aero, bench, machine tool, or maintenance fitters. There is a good demand for machine tool fitters in the area served by the Centre and a large number of men are being trained in this particular branch of the trade. In addition to maintenance, overhaul, and repair work done on the various machines used in the other shops, a number of old machine tools are purchased from time to time and renovated. As a rule these old machines are long past any chance of economic repair, but they afford excellent training in being dismantled, having new parts made and fitted, and in work involved in their truing up and reassembly. When these machines have served their purpose in the fitting shops they are often passed on to the welding section, where they are used for another series of exercises. Both in the fitting and machine operating sections the type of training exercises carried out are of a heavier nature than previously observed at other Centres.

During the machine fitting course each group of trainees makes a number of small-scale models of machine tools, every man making at least one part of the model. In this way the men are given practice in small precision work while assimilating knowledge of the constructional details of the different machines.

Instrument making was only introduced into the Centre a few months ago and the first batch of trainees are now completing their courses.

A small well-equipped shop partitioned off in the main building is devoted to this branch of training, which follows somewhat similar lines to those of other Centres described. The sheet metal working shop shown in Fig. 4 is situated in a separate building in order that the noise associated with this class of work shall not interfere with the other sections. A very comprehensive syllabus has been laid down for the trainees, and this, in addition to ordinary sheet metal working, includes the laying out and making of forms and shapes, panel beating, soldering, brazing, and oxy-acetylene welding in the commonly used ferrous and non-ferrous metals. Each man has his own section of bench with a good kit of tools, and a useful range of shearing, bending, and forming machines are installed for general use.

MACHINISTS

A large well-equipped machine shop, corners of which may be seen in Figs. 1 and 2, occupies a considerable area in the body of the main building. The machines laid down include a widely representative range of makes, types, and sizes, both in the older and latest designs, and, generally speaking, these are of a heavier type than those at the Centres previously discussed. A system of grouping of the different types of machines, such as lathes, millers, grinders, capstans, &c., has been adopted. At one end a miscellanea of shapers, slotters, planers, drills, &c., has been grouped and upon these simpler types of machines new entrants receive their elementary training before passing to the more complicated machine tools. The courses are so arranged that every man spends a certain time upon each machine in his particular group, passing from the elementary through progressive stages to the more advanced modern machines and doing increasingly complicated work to finer limits. Trainees are expected to do all their own machine setting and they also receive a certain amount of practical tuition in the hardening of tools. The degree of accuracy expected increases with each step in training; for example, a grinder, after one month, is expected to work consistently to a limit of 0·0015in.; by the end of five months this limit is reduced to 0·0002in. Men who attain a particularly high standard in the machine shop are given the opportunity of entering the precision tool room for the final period of the training. In the tool room, shown in Fig. 7, the men work on a variety of typical precision machines in the production of jigs and gauges, to the limits and standards called for in the trade. Not only are they taught the machining side of this work, but also the use of high-class precision instruments for setting out, measuring, and checking.

OTHER TRADES

In common with other Centres, work is at present concentrated on training men for the engineering industry, but there are still a number of motor mechanics, body builders, carpenters, bricklayers, plasterers, and painters at Leeds.

The motor mechanics' section occupies one corner of the main building adjoining the fitters' and machine shop. Here the men work on a large selection of different makes of modern vehicles, and they are taught the principles of construction, methods of fault finding, repair and overhaul. In the body building section men are engaged on the construction and repair of bodies for passenger and small commercial vehicles and private cars. These two sections of the Centre work in close conjunction and frequently completely dismantle and overhaul old and damaged vehicles purchased for training purposes.

The bricklayers spend much of their time on various exercises in the main yard, and at present, as part of their training, are constructing a new wet weather shelter adjoining one corner of the yard.

The carpenters were originally housed in the main building, but as this space was required for the training of Army fitters a large new shop was erected on an adjoining vacant site. Many of the exercises carried out in this department are of a practical nature and the finished products are used in other parts of the Centre.

The painters receive their instruction in a small shop adjoining the sheet metal workers and do most of their practical work in various parts of the other buildings.

Although we have only described three of the fifteen training Centres laid down in various parts of the country, our readers will appreciate that the work done closely follows the same lines in them all. Every trainee before he leaves to take outside employment is a potential craftsman, who has received an excellent practical training which enables him to undertake with confidence and ability the work in which he has specialised. The method of selection adopted in the first weeks spent at a Centre almost completely eliminates the chance of a trainee wasting his time on work for which he is not suited. Throughout our visits we were particularly impressed with the high standard of workmanship which was not only expected, but invariably obtained from the men, and the genuine enthusiasm which was everywhere apparent. At none of the Centres did we find any conspicuous "window dressing" of special test pieces made by the men, but in every department were shown typical pieces being made by the men undergoing training at the time, and the same high standard was present in all cases. Naturally, the successful working of the scheme depends largely upon the organisation and training ability of the managers and staffs at the Centres, and the gratifying results invariably obtained are evidence of their success.

HOARDING OF PETROL.—It is believed that there are many persons who have petrol in their possession without proper authority, and that they would be willing to surrender it but for the fear of being prosecuted. The Home Secretary and the Secretary of State for Scotland therefore wish it to be known that any petrol which is voluntarily surrendered on or before July 8th will be accepted without further steps being taken. Any person wishing to surrender petrol should inform the police immediately. It is illegal for any person to keep petrol unless he holds a licence from the local authority and observes its conditions. This does not, however, apply to the keeping of a quantity not exceeding 3 gallons, provided it is kept in vessels each containing not more than 1 pint, or to the keeping of a quantity not exceeding 60 gallons for use in the person's own motor vehicles or engines, and not for sale, provided the prescribed conditions are observed.

Beau de Rochas, Otto and the Four-Stroke Cycle Engine

By A. K. BRUCE

ON May 14th, 1938, there was unveiled, at the house in Paris of the Société d'Encouragement Pour L'Industrie Nationale, a commemorative plaque inscribed as follows :—

Beau De Rochas
1815–1893

Lauréat De La Société D'Encouragement Pour Son Invention, En 1862, De Cycle A 4 Temps, Origine Des Progrès Des Moteurs A Combustion Interne Et Du Développement Des Industries Automobile Et Aéronautique.

Alphonse Beau de Rochas, who first enunciated the fundamental mechanical arrangement for all successful internal combustion engines of piston type, was born at Digne in the Basses-Alpes on April 5th, 1815. Very little is known about his early days, but at the time he applied for his now famous patent he was an engineer attached to the Service Central of the Cie des Chemins de fer du Midi, though it has not been possible to find, in the archives of the company, details relating to his activities when in their employment. The claim covering the four-stroke cycle is contained (with other claims) in French patent No. 52.593 applied for on January 16th, 1862, and sealed by the Office national de la Propriété industrielle on March 10th. The title of this document is as follows :—" Perfectionnement dans les conditions pratiques de plus grande utilisation de la chaleur et, en général, de la force motrice, avec application aux chemins de fer et à la navigation " (" Improvement in practical conditions for attaining greater utilisation of heat and in general, of motive power, with application to railways and to navigation ").

Whether this perceptive genius was alive to the significance of Carnot's " Reflexions sur la puissance motrice du feu et sur les machines propres à développer cette puissance," cannot now be determined. The probability is that he had considered the Carnot theory, and he certainly apprehended the vital importance of high pressure at the commencement of expansion. In his patent specification, Beau de Rochas remarks that " the utilisation of the elastic force of the gas depends upon a function closely allied to prolonged expansion and its advantages. This is the pressure, which should be as great as possible, to produce the maximum effect. Here the question clearly is to obtain expansion of the gases when they are hot, after compressing them while cold."

It is noteworthy that Beau de Rochas, a locomotive engineer, developed his ideas in connection with locomotive boiler design. What he suggested, inter alia, was that the firing of the boiler should be by gas instead of by solid fuel, the gas to be derived from bituminous coal by means of a gas generator or producer. Part of the gas thus made available was to be utilised in a gas engine for the direct production of power. Going on to describe in some detail the operation of gas engines by the method used in the Lenoir engine, he comes finally to the description of a method of working unknown in the Lenoir or any other then existing or earlier engine. This method was the four-stroke cycle (" cycle à 4 temps ") with ignition at the end of compression. The significant part of the patent so far as relates to the four-stroke cycle is as follows :

" Ces conditions sont en effet au nombre de quatre : (1) le plus grand volume possible du cylindre sous la forme du minimum de surface périphérique ; (2) la plus grande vitesse possible de marche ; (3) la plus grande détente possible, et (4) la plus grande pression possible à l'origine de la détente."

((1) The largest possible cylinder volume with the minimum boundary surface ; (2) the greatest possible working speed ; (3) the greatest possible number of expansions ; (4) the greatest possible pressure at the beginning of expansion.)

Examination of the text of the description given by Beau de Rochas shows that what he had in mind was the application of his cycle to a double-acting engine thus giving a firing stroke for each revolution of the crankshaft. This, however, does not affect the working process described. Apart from the patent, Beau de Rochas left a brochure entitled " Nouvelles Recherches sur les Conditions Pratiques de plus grande utilisation de la Chaleur et en Gènèral De La Force Motrice." In this now famous brochure, the inventor deals in fuller detail with his proposals, including the section which relates to the four-stroke cycle gas engine. The brochure was published in Paris by the Libraire Scientifique, Industrielle and Agricole, E. Lacroix, 15, Quai Malaquais, 15. The date is 1862, the price 16 Francs, and Beau de Rochas is described on the title page as " Ingénieur attaché au Service central des Chemins du Midi."

Shortly after the date on which he applied for his patent and wrote his brochure, Beau de Rochas appears to have left the service of the Chemins de fer du Midi. Thereafter, he devoted himself entirely to the inventive work for which he was so singularly qualified. His labours were quite unremunerative and (to quote one of his biographers, Monsieur Walckenaer) " Beau de Rochas, son brevet à la main, frappa à différentes portes, mais personne ne l'écouta et, dès l'année suivante, il cessa d'en payer l'annuité " (Beau de Rochas, his patent in his hand, knocked at different doors, but no one listened to him ; and in the next year he ceased to pay the patent fees.) And so lapsed thus prematurely this historic patent. After struggling for about 30 years, the inventor died in poverty at Vincennes on March 27th, 1893, having nearly completed his seventy-eighth year. We are told by one who knew him (Monsieur Marcel Lunet) that at the time of his death Beau de Rochas was working on a hot air engine which he called the " Thermodyne."

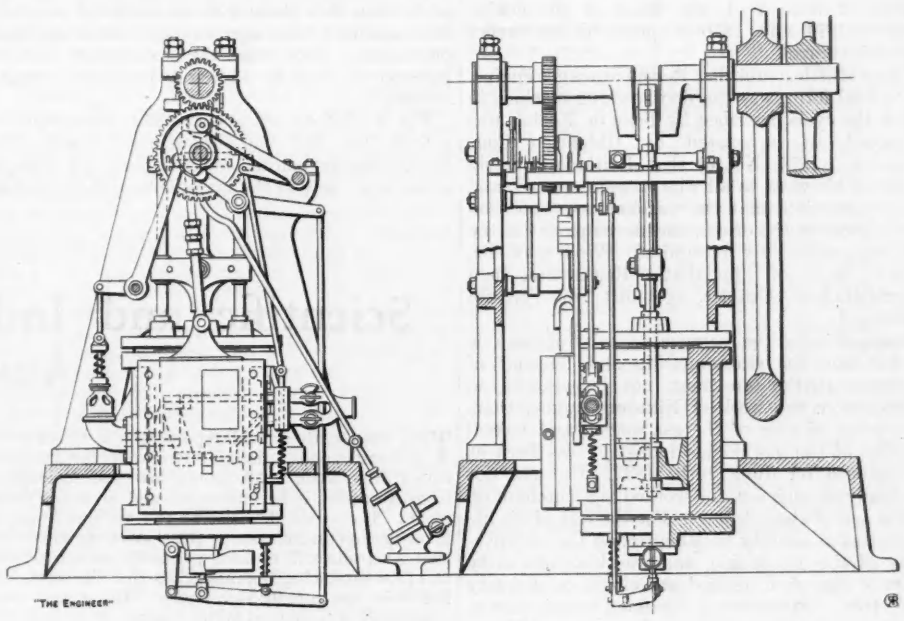
It is characteristic of the technical sagacity of this remarkable man that he should have described, as long ago as 1862, the recuperation of the heat in the exhaust gases from the gas engine by passing them through the flues of a steam boiler.

Beau de Rochas was a man of great independence as well as of outstanding inventive talent, and as the enunciator of the four-stroke cycle his fame is secure. In French mechanical science he had a predecessor in Philippe Lebon, who, at the very end of the eighteenth century was working on the design of internal combustion engines. There is a French patent of Lebon in 1799, and in 1801 a further patent applied for by him describes an engine operating on a two-stroke cycle. Elsewhere than in France there are early gas engine patents applied for by Lemuel Wellman Wright in 1833, and by William Barnett in 1838, both Englishmen. Barnett appears to be the first investigator who clearly discerned the importance of compressing the mixture of gas and air in the engine cylinder prior to ignition. He also devised means for producing ignition which anticipate, in essential respects, those employed many years later by Otto. The French Patent of Degrand No. 36.801 dated June 1st, 1858), contains a later proposal for the practical application of the piston in producing compression in the gas engine, and further reference to this important mode of working is found in the British patent (No. 1840, communicated on July 22nd) of Francisque Million, a Frenchman. This patent contains a number of interesting and practical suggestions.

Etienne Lenoir, in French patent No. 43.624 of January 24th, 1860, describes his " Moteur à air dilaté par la combustion du gaz " (" Motor with expanded air produced by the combustion of gas "). This was a horizontal double-acting spark-ignition engine, and it has the distinction of being the first gas engine to be brought into general use. It was built by the Société des moteurs Lenoir (Gautier et Cie, Paris), and we read that as many as 400 of these engines were at work in Paris alone within five years from the date of the patent. About 100 of them were built and sold in Great Britain. The significant dates show that just as the construction of the Lenoir engine was commencing on a production basis, Beau de Rochas published his description of an arrangement destined to become universally adopted for all internal combustion engines of piston type. It was not, however, until about ten years after the enunciation of the " cycle à 4 temps " that a four-stroke engine was actually produced.

It appears certain that the first engine built in precise accordance with the arrangement described by Beau de Rochas was the work of Christian Reithmann, court watchmaker in Munich. There is good reason to believe that as early as 1852 Reithmann, who made a hobby of the gas engine, had constructed an engine using a mixture of compressed air and hydrogen gas, the mixture being ignited by electric spark. This engine was used for providing power for driving the machines in Reithmann's workshop. Owing to the comparatively high cost of hydrogen gas and a certain difficulty in handling it, the use of the engine appears to have been discontinued in 1855. In 1858 it was modified and made to run on town gas. Not until 1860, when he heard of the development of the Lenoir engine and its successful use in Paris, did Reithmann decide to apply for a Bavarian patent. This was granted to him by decision of the Royal Government of Upper Bavaria on October 5th, 1860, the duration of the patent being two years. From the account of the matter given in Volume XXVIII (1884) of the Zeitschrift des Vereines deutscher Ingenieure, the patent expired without any profit to Reithmann, who failed to find the financial support necessary in the exploitation of such an invention. The fact that no monetary reward came to him in respect of his long continued labours with this engine did not, however, interrupt the work, and some time between 1872 and 1873 Reithmann much improved the engine, which, as re-designed, was in regular operation in the court watchmaker's workshop until 1881.

This pioneer four-stroke gas engine had a single cylinder, arranged vertically, the bore being 97 mm. stroke 110 mm. It appears to have commenced as a double-acting engine with two pistons embodying an opposed piston arrangement. After a number of radical changes, it arrived at the form in which it is shown in the illustration, that is, a single-acting piston driving through piston rod



REITHMANN'S GAS ENGINE

and connecting rod on to a superimposed crank. As has been pointed out by Dr. Arnold Langen, it is only in this single-acting form that Reithmann's engine could have worked in accordance with the four-stroke cycle. When, in 1884, litigation took place on the subject of Otto's (German) patent No. 532, Reithmann's engine had for some years been laid aside, but the watchmaker was able—in accordance with the request of the Provincial Court at Munich—to assemble the parts of the machine and demonstrate it as a practical four-stroke engine. This court recognised, after listening to numerous witnesses, the priority of Reithmann over Otto. The Deutzmotorenfabrik entered an appeal, which appeal was upheld by the Upper Provincial Court, who found that the priority of Reithmann had not been proven. It must be noted, however, that Deutzmotorenfabrik had, in the meantime, purchased Reithmann's engine together with any rights of prior use which might be based on it. Consequently, so far as concerns recognition of his priority, Reithmann was only interested from the point of view of his reputation as an inventor. He did not press this interest, and explained to the Upper Provincial Court that the many transformations made on the engine rendered it impossible for him to recollect when it had first worked as a four-stroke engine. In relating the history of this matter, Dr. Langen mentions ("60 Jahre Viertakt-Motor") that Professor Karl von Linde saw Reithmann's engine in its four-stroke form in 1872 and again in the same state in Reithmann's workshop in 1874. Other witnesses stated that a toothed-wheel gearing of ratio 2 : 1 was fitted to the engine between 1874 and 1876 in place of the earlier eccentric control.

There is little doubt that Reithmann's gas engine, in its final form, was the first working machine in which the cycle described by Beau de Rochas was employed. It is related by Uhland ("Constructeur," 1874, No. 6) that Reithmann freely disclosed his work to all who were interested, and it is appropriate that the watchmaker's position as a pioneer in the design and development of the gas engine be duly recognised. Well may Dr. Langen write of him that "Reithmann, dem unermüdlichen Grübler, gebührt die grösste Achtung."

Recognition of the technical sagacity of Beau de Rochas and the craftsmanship and tenacity of Christian Reithmann must not be allowed to detract from the work of Nikolaus August Otto. This great pioneer of the gas engine and virtual founder of the gas engine industry, was born at Holzhausen on June 14th, 1832. He was not originally an engineer, and worked as a merchant up to the age of about thirty. For the rest of his life of incessant activity he laboured on the improvement of the gas engine, and was less than sixty years of age when he died at Cologne on January 26th, 1891. Apart from his acumen as an inventor, Dr. Otto—with the faithful collaboration of Eugen Langen—created manufacturing facilities of a kind never previously applied in the construction of internal combustion engines, and it was largely in virtue of the high order of manufacturing technique, and the scrupulous attention to all details, that the Otto gas engine made such rapid progress as an industrial machine. Dr. Otto, it must be acknowledged, was not always correct in his theory. The same is true of many other workers in this field, including Rudolf Diesel. Nevertheless, Otto remains the most successful of all gas engine inventors. No one could be better qualified to speak of Otto's contributions to engineering science and industry than was Sir Dugald Clerk, who writes of him as follows :—

"He devoted his whole life to the study and development of the gas engine, beginning at the age of twenty-two years and continuing steadily on until his death—thirty-seven years of persistent work. During that long working period he experimented with nearly every form and cycle of engine. His early work dealt mainly with the atmospheric type in varied forms, but after 1876 he devoted himself to the four-cycle compression engine. . . . His death at the comparatively early age of fifty-nine was a great loss to the gas engine industry, but he had accomplished the heavy pioneering work for the world."

While a detailed account of Dr. Otto's work is not here attempted, it may be mentioned that in 1862 he built a small experimental engine in which an effort was made to realise the successive suction, compression, expansion and exhaust strokes. This engine was of two-crank arrangement with opposed pistons, and appears to have been constructed, under Otto's supervision, by the Cologne mechanic Zonz. They did not succeed in getting it to run, though Otto worked on the engine for about a year before abandoning the scheme and concentrating—as he did for the succeeding fifteen years—on the free piston atmospheric gas engine. Otto was, of course, familiar with the Lenoir engine, and had the direct-action gas engine experiments of 1861–62 succeeded it is unlikely that there would have been any Otto and Langen free-piston engine. As it happened, the free-piston engine took the place of the Lenoir engine, and held it until the development, in 1876, of an engine which successfully embodied the working principle laid down by Beau de Rochas.

The German patent for the Otto gas engine (No. 532) was granted with priority from June 5th, 1876. After being the subject of the litigation already mentioned, this famous patent was set aside by a decision of the Supreme Court of the Reich announced on January 30th, 1886. It must be remembered that the Gasmotorenfabrik Deutz held, at the outset, a complete monopoly of the four-stroke cycle, and declined to grant manufacturing licences to other German firms. Under such circumstances, persistent attack on the patent was inevitable, and this finally succeeded. Dr. Arnold Langen has pointed out—with much truth—that "Commercial success never remains hidden. The greater the degree of success the stronger is the desire and the greater is the effort made by the less successful to equal or surpass the results obtained by the successful. Should it happen that infringement is hindered by legal protection, then those who are hindered generally form a united front against those who enjoy legal protection. This was the experience of the patentee of D.R.P. 532 and his foreign applications."

For a variety of reasons the annulment of patent No. 532 had unfortunate results. As Hugo Güldner pointed out long ago, the collapse of the monopoly in the manufacture of four-stroke engines based on the patents of N. A. Otto was detrimental to the entire development of the internal combustion engine. The Otto patent had the effect, while it remained in force, of compelling all competitors to study the development of the two-stroke and other alternative systems. Prominent among these competitors were the British engineers, John Henry Hamilton, James Robson, James Atkinson and Dugald Clerk. Had this activity been continued under the pressure of necessity, there can be no doubt that it would have led to the earlier development of superior types of internal combustion engines, particularly two-cycle engines. When the compelling cause was removed, makers of internal combustion engines in Germany—as happened some years later in Great Britain—preferred to revert to the easier way of Otto, with results highly prejudicial to the rate of technical progress.

The history of the evolution of the four-stroke cycle engine illustrates the old truth that all inventions have their pedigree. In this evolution a distinguished place belongs to Beau de Rochas, who described, with singular clarity, the arrangement which must be employed in an internal combustion motor in order that the heat supplied can be efficiently utilised in producing power. Dr. Arnold Langen has aptly described the work of Beau de Rochas as "eine prophetische Schilderung des Viertakts" ("a prophetical adumbration of the four-stroke cycle"). It is indeed remarkable that a descriptive patent so masterly in its comprehension should have been virtually ignored at the time of its delivery and for long after. No injustice is done to Beau de Rochas by pointing out, however, that the idea of compressing the gas and air charge can be found in earlier writings than his. The Frenchmen Lebon and Million, the Englishman Barnett, and the German Schmidt all contributed suggestions, though it was left for Beau de Rochas to formulate the complete theory, and for Nikolaus August Otto to translate it into a mechanical and commercial success.

Scientific and Industrial Research in Australia

THE thirteenth annual report of the Council for Scientific and Industrial Research for the year ended June 30th, 1939, which has just reached us from Australia, is an interesting and revealing document. The space devoted to the various kinds of investigation undertaken by the Council demonstrates that Australia still remains primarily an agricultural and food-producing Dominion, but that the secondary industries are rapidly developing. The greater part of a report of considerable size is taken up by bulletins of progress of plant investigations, entomological problems, weed investigations, animal health, and nutrition studies, and forest products research. References to irrigation, too, are concerned rather with the welfare of the soil than with engineering structures. The erection of a National Standards Laboratory and an Aeronautical Research Laboratory, however, show that the needs of the new secondary industries are not being neglected. In what follows we reprint a few short extracts from the report which may prove to be of interest to engineers.

Irrigation Settlement Investigations

Commonwealth Research Station (Murray Irrigation Areas), Merbein, Victoria.—The Commonwealth Research Station is situated on the Sturt Highway, 10 miles from Mildura, on the main road from Mildura to Adelaide. The work of the station is principally directed towards problems associated with the irrigation of the horticultural lands of the middle and lower Murray and the production and processing of the grapes grown in these areas.

Soil preservation and reclamation studies are proceeding steadily, and these investigations are closely associated with drainage and reclamation works in the various irrigation centres. The older irrigation areas in Australia have in most cases now reached the stage where the lands, having been irrigated for a number of years, show evidence of declining productivity. This decline was accepted until recent years as inevitable in irrigation settlements. More recently, however, as the causes of soil deterioration and the amelioration measures for correction have been more accurately defined by investigations, there has been an impetus in all States to consider drainage and other measures for soil improvement. In this respect, it is pleasing to record a very considerable measure of success in some of the irrigation settlements. Mildura, Red Cliffs, and Merbein, totalling 33,000 irrigated acres, are now provided practically throughout with drainage facilities, and there is very general evidence and recognition of the restoration and safeguarding of fertility resulting from these works. At the present time, reclamation is proceeding in the settlements of Nyah, Woorinen, and Kerang (Victoria); Coomealla (New South Wales); and Renmark, Berri, Barmera, and Waikerie (South Australia).

The part played by the station in these works is to examine and report on the extent and cause of soil wastage, and to investigate the responses of the affected areas to sub-surface or to surface drainage. Following such an examination, including a study of the crops grown, it is possible to suggest remedial measures and the type of drainage that will most economically and efficiently serve the district concerned. Throughout the work, including the planning of the various drainage schemes, the staff of the station is closely associated with the State Departments concerned, and with the various producers' organisations of the irrigation districts.

There is a close co-operation with other branches of the Council, particularly the Division of Soils, which has rendered continuous assistance in the planning of soil, irrigation, and drainage investigations; and also with the Division of Plant Industry, in the initiation and carrying out of investigations dealing with the plants.

Irrigation Research Station (Murrumbidgee Irrigation Areas), Griffith, New South Wales.—The Irrigation Research Station at Griffith was established in 1924. The object of its investigations is the elucidation of cultural problems associated with irrigation agriculture, and, as such, many of its investigations are concerned with the soil.

The progress made in irrigation research has now enabled the past work to be reviewed in detail, and principles have been formulated for the design of new areas or the irrigation of existing farms. As a result, work has commenced on the lines indicated for secondary irrigation research, and more intensive extension work to apply irrigation research results to the farms on the area is being organised in co-operation with settlers and the State authorities concerned.

Following on the fundamental research work, it has been possible to analyse systematically the chief factors controlling the amount and distribution of water applied by furrow or border irrigation, namely, soil type and tilth conditions, slope, length of run, and flow rate. The study of the interaction of these variables under control conditions has greatly

simplified irrigation technique, and has provided a new method of approach to the problems of choosing suitable slopes and lengths of run in relation to soil when designing new areas, or in selecting suitable irrigation methods to meet existing conditions of farm lay-out. These experiments have emphasised again that the control of the flow rate per furrow or border stands out as the most important single factor in irrigation management. There is often room for much improvement in the control of the flow rate, and investigations are in progress on methods of distributing water to furrows and borders. Various types of apparatus have been designed, and control devices developed in other countries are being used in field tests.

A start has been made in the analysis of waters from the various rivers and storage basins of the State. The object is to collect systematic data of the salt and silt content of the waters. The result will be valuable for hydrological and irrigation interests. To determine the best technique of sampling and analysis, the studies so far are of a preliminary nature. The work will be done in co-operation with the Water Conservation and Irrigation Commission of New South Wales, which will collect the samples and take records of river heights, rainfall on the catchments, inflows and outflows to storage basins, &c.

FOREST PRODUCTS INVESTIGATIONS

An important result of the year's work has been the preparation for publication of a Timber Handbook, which, for the first time, provides engineers and architects with tabulated data on the strength properties of Australian timbers, in a form suited to the designer. It has taken a number of years to provide the experimental data required, and a large part of the year under review to make the necessary calculations and arrange the tables. This publication is now in the printer's hands. A sum of £600 has been donated by various timber interests in all the States towards the cost of printing the handbook.

The outstanding feature of the year's work has been the completion of draft technical standard No. 0·2—Nomenclature of Australian Timbers. The aim of this publication is to standardise the trade names of timbers and so reduce the disabilities due to the existing confusion of names. It is also intended to link the standard trade names with a standard reference name of the botanical type that will remain unchanged despite any future splitting of species by botanists or changes of authorship under international botanical rules.

Most military aeroplanes are now built of metal, but in times of emergency it appears likely that it would be necessary to construct large numbers of planes built of Australian timbers. It has been decided that research work on wooden aeroplanes will be carried out by the Council's Aeronautical Research Laboratory and the Division working in co-operation. A list of Australian timbers that may prove suitable for aircraft work has now been prepared; hoop pine appears to be one of the most promising species. A start has been made on research work in connection with the design of wooden wing spars.

FISHERIES INVESTIGATIONS

Occupation of the newly erected biological laboratory in the Fisheries Reserve, Cronulla, took place during the last week of June, 1939. The building contains offices and a strong room, one bacteriological and one chemical laboratory (with common preparation room), five biological laboratories, a dark room, a balance room, a library, a stock room, and a draughting room. Several storage rooms and a workshop are also included in the new works. The pre-existing (hatchery) works have been reconditioned and adapted. They include a centrifugal pump with pipe line to a 25,000-gallon concrete sea water reservoir, from which there is a gravity feed to the former hatchery buildings, which have been converted to contain two biological laboratories, a projector room, and a large main experimental aquarium. The latter is supplied with ordinary sea water under pressure, and conditioned (heated or chilled) sea water is also available for experimental work. Extra working space is also available in this room, which is fitted, in addition, with three thermostatically controlled refrigerating chambers (two maintained at zero and one at 30 deg. Fah.), and a small canning plant. A small commercial type smoke house and a net storage and fish-processing shed have been built on the foreshore, while a small jetty has been constructed from the end of which certain experimental work can be carried out. The large concrete tidal pond, 100ft. by 42ft., will be reconditioned during the coming year. For estuarial surveys, a 16ft. 3½ H.P. skiff has been constructed and for field work a 2-ton Bedford mobile unit has been acquired and fitted with the necessary apparatus.

STANDARDS, TESTING, AND RESEARCH FOR SECONDARY INDUSTRIES

National Standards Laboratory.—The University of Sydney has greatly assisted the establishment of this laboratory by providing a suitable site, 250ft. by 230ft., within its grounds. Plans for the laboratory have been prepared in consultation with the authorities of the National Physical Laboratory of Great Britain, who have been most helpful in this and other ways. A contract for the excavations and foundations is to be let early in August, and tenders for the erection of the main building will be invited at an early date. The cost of erection and equipment will be of the order of £100,000.

The work of the laboratory will be organised in three sections, viz., metrology, electro-technology, and physics. The Metrology Section will be the custodian of the national standard units of mass and length, and, in addition, will maintain the more direct derivatives, such as those of volume, density, and pressure. It will play a vital part in the all-important standardisation of high precision gauges on which modern mass production and interchangeability of parts depend. The Electro-technology Section will be responsible for the derived electrical standards of capacity, inductance, &c. The Physics Section will have charge of the Australian legal electrical standards—the ampere, the volt, and the ohm—and will deal with standards of heat, light, and sound, and with other matters having a physical bearing and not dealt with by the other two sections.

Officers to take charge of these three sections have now been appointed and been sent to the National Physical Laboratory, England, where, amongst other things, they will be responsible for the purchase and calibration of the necessary apparatus for the Australian laboratory. Three travelling studentships have also been created, one for each section, and appointments to them have been made. The three appointees will spend a period of up to two years abroad obtaining special experience in standards work.

Aeronautical Research Laboratory.—Considerable progress has been made with the establishment of the research laboratory for aeronautical and engine investigations. Based on sketch plans prepared by the staff of the laboratory, the Department of the Interior has completed the working drawings for the buildings to be erected on the site at Fisherman's Bend, mentioned in the previous report. Incidentally, the area available has been increased by the lease of an adjoining block of 4 acres, making the total now 14 acres. The whole of it, however, will not necessarily be used for aeronautical work. A contract has been let for the levelling, grading, and fencing of the site, for the roads, and for two buildings—one an administrative building to include staff offices and the physics and fuel laboratories, and the other a workshop building of seven bays for the machine and woodworking shops, mechanical test laboratory, and stores. The greater part of the equipment of these buildings has been ordered.

Two other projected buildings, namely, the engine test house and the wind tunnel, remain to be finalised. Plans are being prepared and will be completed in the near future. The wind tunnel is a large and expensive piece of equipment of a very specialised nature, and it is being designed by the staff of the laboratory. It is advantageous to make and test a small-scale model of this kind of equipment, and the University of Melbourne has kindly consented to construct such a model. In the meanwhile, tenders have been invited for the construction of the necessary 500 H.P. motor, fan, and control gear. The main portion of the tunnel, which is to be 105ft. long and 44ft. wide, with a working section 7ft. high and 9ft. wide, will be made of welded steel. This material was chosen in place of wood, as the maintenance of air-tight joints has proved a problem with wooden tunnels in other countries.

Other Research.—The Executive Committee has given much consideration to the development of research into problems affecting secondary industries. It is impressed by the importance of a thorough study on what may be termed the raw material side of secondary industry, using the term "raw material" in a wide sense, that is, as indicating the present starting materials of industrial processes in Australian factories. In this connection a considerable amount of information has been collected, and in this initial work the Council is collaborating with certain committees which have been established by the new Commonwealth Department of Supply and Development.

Facilities for investigations into physical problems will be available in the building which is being erected for the National Standards Laboratory, and it is satisfactory to know that the officers of that laboratory will have an opportunity of carrying out research work and that their activities will not be limited to the maintenance of the national reference standards and the routine calibration of substandards. It is hoped that the Council will soon be able to provide for the erection of a chemical laboratory for secondary industrial research, and it has been suggested that an appropriate site for such a laboratory would be adjacent to the Aeronautical Research Laboratory at Fisherman's Bend, Melbourne. To some extent, laboratories at existing institutions may be used, particularly in cases where there is provision of special facilities not ordinarily available in a chemical laboratory. Thus, for example, steps have already been taken for the initiation of investigations into foundry sands in the new Metallurgical Laboratories of the Melbourne Technical College.

Information Section.—In the previous report mention was made of the organisation of an Information Section situated at the Council's head office. The section was organised along the lines suggested by the Secretary of the Council, Mr. G. Lightfoot, subsequent to a visit he made to Europe and America in the latter part of the year 1937.

The Oxidation of Lubricating Oils*

THE lubricating value of an oil is more or less a physical property, whereas the value of an oil as a lubricant in the wide sense is ascertained from chemical tests. It is unnecessary to emphasise the fact that resistance to oxidation, the influence of emulsifiers and catalysts all affect the life of an oil and must be taken into consideration when evaluating a lubricant. The production of deposits has been studied extensively. There are still people who believe that the deposit which forms in the combustion space of an internal combustion engine is due to the burning of the lubricant, and the formation of a carbon residue. These people naturally incline to support the carbon residue test. Against them is a strong feeling that this test by itself does not correlate with carbon formation. Analysis has shown beyond all doubt that the deposit on a piston head contains appreciable quantities of combined oxygen. Therefore it must be an oxidation product and not a result of pyrolosis. This fact makes it imperative to give thought to some form of oxidation test. It is probably quite true that an oil with a low carbon residue test will give little deposit in an engine, but it is not true that an oil with a higher carbon residue test will of necessity give more deposit. Whatever test is adopted, there must be some close relationship between the results of the test and the result in the engine.

Of all the many oxidation tests which have been suggested throughout the world there is not one which has commended itself as an international standard or even to any one particular nation. The Sligh test gained popularity in America in 1924. In 1935 it was relegated to a "proposed method," and in 1936 it was abandoned altogether. Yet in 1937 it was adopted in Sweden as an official method, admittedly with some modifications. The Indiana test is really only a modification of the Michie sludge test, and the Air Ministry oxidation test is another modification. At this stage no criticism is being made about the possible advantages of the modifications. Suffice it to say that the various oxidation tests which have been proposed have no doubt served a useful and specific purpose. This is entirely different from standardising a test for universal application. The introduction of a copper catalyst into the Michie sludge test was done to imitate the effect of the copper winding in a transformer. It might well be argued that as copper is not a major constituent in an internal combustion engine the Michie test is not applicable, but it could be made so by replacing copper with iron. Immediately difficulties arise, owing to the numerous forms in which iron exists and the numerous surface conditions which can be produced, even inadvertently. In order to standardise a test of this kind it is necessary to resort to compromise. If it is decided to use copper or iron then the purity must be specified. For convenience it is an advantage to use the purest materials available. The method of polishing is extremely important. The purity of the air, the rate at which it is bubbled through and the size of the air bubble must be stated. The dimensions of the apparatus have their influence. It has been shown that when an engine knocks considerable quantities of oxides of nitrogen are produced, and that they have a very material effect upon the oxidation of the oil, possibly so much that they might completely upset any conclusion based on pure air oxidation.

The Air Ministry test was introduced specifically for aero-engine oils of a type purchased by the Air Ministry. It was not put forward as a general test for internal combustion engine oils. It would therefore be improper to standardise it for universal application. Indeed, it is probably safe to say that the Air Ministry would not support such a suggestion if it were made.

There has been much debate upon the temperature at which an oxidation test should be made. Around the piston rings the temperature must be extremely high, but no one is suggesting that the temperature of the test should compare with piston ring conditions.

These examples are sufficient to show the great difficulties which bestride any effort to standardise an oxidation test. It is conceivable that if standardisation should be necessary then more than one oxidation test may also be necessary.

DELAY-ACTION BOMBS.—The enemy is using delay-action bombs in the course of air raids on this country, and the Ministry of Home Security warns the public to keep away from unexploded bombs and crashed aircraft, the wreckage of which may contain such bombs. Furthermore, it is important that bomb fragments, &c., should not be removed from the scene of a bomb explosion, as they may furnish valuable technical information.

* From a paper "Stepping Stones to Standardisation," by E. A. Evans, delivered to the Northern Branch of the Institute of Petroleum, May 23rd.

The Engineer

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NOTICES TO READERS

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With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

German Troop-Carrying Aircraft

Copies of the Supplement to THE ENGINEER *of June 28th, showing silhouettes of four types of German Troop-Carrying Aircraft, can now be obtained by application at this office at the price of One Shilling per dozen, postage paid.*

WAR EFFORT

HOWEVER deeply we may deplore the collapse of our French ally, we are forced to admit that it has acted as a spur to this country and to the British Commonwealth of Nations. Every part of the Empire is now working as it never worked before, and it has not nearly reached the boundaries of its power. Great as the output of munitions of war is at this day, a few weeks hence it will be greater still, and after that it will still continue to climb upward until it has reached a magnitude which will leave the world gasping. Nothing less will do. Great losses have to be made good; and a great army equipped where a lesser one was visualised. Germany and Italy cannot be beaten by defence alone. Aggression must meet aggression. We must snatch from the enemy the initiative that he has been allowed to hold already too long. It is with that purpose before it that the Empire is employing its vast reserves of man power and material to achieve in a month and without misery what Germany did with tears and tribulation in years. If defence of the Kingdom and Empire were our only thought, a less effort would suffice; it is because we have a greater duty than the protection of our hearths and homes that we are building up a war machine of colossal magnitude. Defence of this realm is the first duty to our hand. It must, and will be, achieved. We do not yet know if Germany intends to attempt a military invasion at once, or whether she will seek first to reduce our powers of resistance by endeavouring to blockade our supplies and starve our fortress. We are prepared for either or for both. And in the right hour we shall, as Mr. Eden has said, make a sortie. Already we have become far more aggressive than was possible during the Battle of France. Minimise as they may the effects of the incessant air bombardments of industrial plants, oil stores and refineries, armament and aeroplane factories, and other military objectives, the enemies, Germany and Italy, must be suffering immense losses from these persistent attacks which they are impotent to prevent, and to which they have, so far, failed to retaliate in equal measure. When we win and hold air supremacy, victory will be in sight. And we shall win it. Every successful raid brings it nearer, for it must never be forgotten that each success "counts two on a division"; it decreases the enemies' power to attack us and increases our power to attack them. There is no man or woman in the wide Empire and amongst millions of other peoples who does not pray that the initiative in the air which we have seized may be continued and extended ceaselessly and remorselessly.

In the House of Commons and in a broadcast address on Thursday, June 27th, Mr. Herbert Morrison told the world something about the magnitude of the effort being made by the Ministry of Supply. For obvious reasons he withheld actual figures of output of war materials of all kinds, but he indicated the rates of increase by percentages. Now, percentages, as he admitted, mean little or nothing if we do not know the datum lines upon which they are based. The man who grows two plums this year on a tree which bore but one last year may justly claim a hundred per cent. increase. Yet his crop is insignificant. We must not forget this fact when considering Mr. Morrison's figures. At the same time, we must not exaggerate it. We know that in the production of certain classes of war material—shall we say planes and tanks?—the output was already high at the beginning of the year. Percentage increases do therefore mean important accretions. On the other hand, some of the most startling increases by percentage may indicate that the output of such items before the push began was relatively small. It is fair to assume that in the few weeks of intensive warfare in France and Flanders we learnt a great deal. May we not conclude that these rapid advances in output indicate that we are profiting by our lessons? That having underestimated the importance of certain things, we are now correcting our mistakes and accelerating output at a great pace? Furthermore, it is probable, to say the least, that certain devices were used tentatively, and those that were proved effective are now being put into production. Finally, the loss of the coastline of France by laying us open to the threat of invasion, has made the production of certain defensive weapons in enormous quantities imperative and superlative efforts are being made to meet the expected requirements. With these considerations in mind, we may take Mr. Morrison's percentages as indicative of a genuine and notable increase in the rate of output. He himself made no claim that it was yet completely satisfactory, but he did claim that progress was good and that it would be better. Here are his principal figures comparing the monthly rate of production in June with that of April last. The rate of output of cruiser and infantry tanks was increased by 115 per cent., and of carriers by 64 per cent. In guns of various kinds the increases range from about 50 per cent. in two items up to as much as 228 per cent. for another item. In small arms, rates of output increased in the two months by between 49 and 186 per cent.; and in ammunition of various kinds between 35 and 420 per cent. Taking the most conservative view of these figures and recognising fully the limitations which are inherent in percentages, we must agree with Mr. Morrison that they do show "an encouraging spurt in production during these critical weeks," and, resolutely closing our mind to all *arrières pensées*, let us recognise that the success of the forward drive is due to the energetic measures taken by Mr. Morrison and Mr. Bevin. The former is organising the available means of production with skill, energy, and imagination; the latter has overcome the resistance or inertia of labour. Much remains to be done, but we are now on the way to do it. Plant must be used for longer hours and more dilutee labour must be used. Employers must be encouraged to face resolutely difficulties and obstacles which they regard as insurmountable, or be compelled by firmness to overcome them. Some of the difficulties are local, as for example the finding of house room for a greatly increased working population, others are connected with management, and yet others with a disinclination to employ a standard of skill below that hitherto engaged. We are confident that all can be met and mastered if the resolution and firmness of purpose is there. A still greater multiplication of effort and output is possible, and we do not doubt for a second that it will be attained.

We have observed with particular gratification Mr. Morrison's remarks on over-elaboration. That he should have dealt with a subject which formed the text of a leading article in these columns only a few days before is, we venture to suggest, one of those coincidences that happen when the same classes of problems are being studied at the same time by active minds. As a wholly non-technical man, the Minister of Supply must have relied for the information on which he based his remarks in some measure upon his own observation, but in greater measure upon the comments and advice of technical people. That must be accounted a good sign. It is very difficult indeed to persuade people who have been brought up on the doctrine of the best that a lower standard of excellence may be adequate for specific purposes—that, as Mr. Morrison put it, "we must beware of over-elaboration of design, of frills, of fancy pieces which were not vital to the weapon doing its job . . . we must not worry too much, as the British have worried rather too much in the past, about having everything finished to a fine point and with a beautiful finish." That, let us admit it, is rank heterodoxy; it stinks to the heaven of all trained engineers. But it is fundamentally sound policy when output is the prime consideration, and particularly in the case of products which are going at once into action and of which the life may be of the shortest. Let every part be of the best quality and of the highest accuracy where high quality and accuracy are essential; but elsewhere lower the quality of the material and omit the grinding, draw-filing, emery-papering, and polishing where they cannot make the weapon more effective. The War Office, and possibly the Admiralty too, may have to sacrifice many things in which they have been brought up, but just as the battle-dress of to-day has been cut down to the limit of effectiveness, so must the arms and equipment be lowered to that point where nothing else remains but complete efficiency for the intended purpose. We cannot afford to keep the unnecessary. If a smooth-bore gun would fill a defined *rôle* as adequately as a rifled gun, then we must have the courage to give up rifling and save the cost in time and money which it entails; if some lower quality of metal will serve its turn as well for a definite purpose as the very best metal; or if a casting may replace an expensive forging, then we must, in defiance of tradition, be satisfied with what we esteem less than the best. But, above all, it is essential that designs should be established and allowed to remain, so that standardisation, without which mass production is impossible, may prevail. On all these matters Mr. Morrison will require the help and guidance of technical men, but in the end he will have to rely upon himself to accommodate differences of opinion, and to select the compromise which gives the greatest promise of output combined with effectiveness.

"The Engineer" Since 1856

IN this, the first issue of our 170th volume, a number of changes have been made in the arrangement of the pages of THE ENGINEER. No such considerable alterations have occurred in one step since the first number of the paper appeared in 1856, and some explanation is due to our readers. We take the opportunity, too, of tracing in outline some of the improvements that have been made to THE ENGINEER from time to time during a life of well over eighty years.

A year ago THE ENGINEER was maintaining an editorial larger than it had ever before achieved and there was every prospect that the expansion and improvement of the paper would continue; for new ideas were not lacking in this office. But the war intervened. Its effects were at once restrictive. The printing of the paper was transferred temporarily to the country and the size of each issue was reduced, partly to economise in paper, which was rationed soon after the outbreak of war, and partly to ease the burden on printers who were unaccustomed to our style. Censorship made it impossible for us to publish certain types of articles, the information in which might have proved useful to the enemy, and governmental control of the iron and steel, non-ferrous metal, and fuel industries made it superfluous for us to publish each week "Current Prices for Metals and Fuels," a feature which had formerly taken up a whole page in each issue. Substantially, however, the "make-up" of THE ENGINEER remained that which had become standardised before war broke out. Only one further change was made in the following months. By reducing the number of abstracts of Patent Specifications printed in each issue space was saved for other purposes.

As our readers are aware, THE ENGINEER is now again being printed in London. But as a result of the extension of the war to Scandinavia there has been a heavy reduction in the volume of paper and papermaking materials reaching this country. In company with all other publications THE ENGINEER has been forced to economise still further in the use of paper. A thinner and lighter paper is to be used for the advertisement pages, and other savings, small individually, but considerable in the aggregate, have also been effected. But despite all the economies that we have made, calculation has shown us that it is still necessary to reduce a little further the number of editorial pages. That fact affords the explanation for the changes that have been made in the editorial make-up. It was felt, and we think our readers will agree, that in a smaller paper the various "features," which appear week by week, would, if retained in their previous form, occupy an unduly large amount of space. Some kind of pruning had therefore to be undertaken. For the duration of the war no more abstracts of British Patent Specifications will be published. This loss will be the less regretted, in that many of the more interesting inventions produced in time of war must of necessity be kept secret until hostilities cease. Those columns of short paragraphs, headed respectively Rail and Road, Air and Water and Miscellanea, that formerly filled a page near the middle of each issue, will be found transferred to the final page, taking the place of the patents. French Engineering Notes—alas!—comes to an end through no wish of ours. As a result of these alterations a whole page in the early part of the paper has been thrown open for other uses.

But the more noticeable change, one that must have attracted the attention of any regular reader perusing these notes, is that affecting the central opening. For more years than any of us would care to remember the left-hand page of this opening has been occupied by engravings and the right-hand page by the leading articles. That arrangement was distinctive to and characteristic of THE ENGINEER. It was eminently satisfactory and it was only after long discussion that we decided upon the change. For in our present smaller issues we cannot afford each week to give up so much space to illustrations that were placed in that position for their appearance as much as for their intrinsic importance. By the sacrifice another page is made available for matter of greater importance. The leading articles have now been placed on the left of the opening, which, when its unfamiliarity has had time to wane, we think our readers will agree retains the dignity and restraint that has always distinguished it.

THE ENGINEER has always prided itself on the care that has been bestowed upon its "make-up." Our readers, we believe, will share with us regret to see arrangements that had become almost traditional thus broken up, and yet approve the action we have taken. In its new, and after all not so very much altered, form, we shall endeavour, with the help of our printers and block makers, to retain a high standard in THE ENGINEER, not only in the quality of the material published, but also in general appearance and printing, despite difficulties that may arise from the use of unfamiliar paper or from other unforeseen events.

Many changes have occurred in the "make-up" of THE ENGINEER since it was first published in 1856. Those effected in this issue are only the latest of a long series. It may be of interest, especially perhaps to our older readers, to trace the origins of some of those "features" which have become so familiar.

In the first few issues of THE ENGINEER during 1856 there were no leading articles such as we know to-day. Their place—on the right-hand central page, a position they have occupied uninterruptedly until the present issue—was taken by a "Note Book"—consisting of a series of short paragraphs dealing with the topics and events of the week and containing editorial comment upon them. But within three months the paragraphs had become much longer and each had been awarded a separate sub-heading, so that they became more like true leading articles. As the years went by they became longer and longer and fewer in number, evolving gradually into the familiar "three-deckers" of to-day. Though thus early the paragraphs became in effect short leading articles, it was not until 1858 that the general heading "Note Book" was dropped. At that time and for many years thereafter the leaders were preceded, in very small type, by the shorter Letters to the Editor; the longer ones—and letters in those days were sometimes very long—were assigned to another page. No special attention was at first given to the page on the left of the central opening, facing the leaders. The practice, however, gradually grew up of placing some kind of illustration, woodcut or line, on that page, and after 1867 it became a normal, though not quite an invariable, practice to do so.

In the first issue of 1866 a new feature appeared. A complete page was given up to three columns of short paragraphs headed respectively Railway Matters, Notes and Memoranda, and Miscellanea. At first it was regularly placed in the early part of the paper. But later it became peripatetic to suit the convenience of the editor. Occasionally, presumably when the editor was unable to find a suitable whole-page engraving to occupy that position, it was placed in the central opening opposite the leaders. Examples of this practice are to be found at least as late as 1905. With the advent of the photographic half-tone engraving, which was rapidly displacing wood-cuts during the "'nineties," it was found advantageous to have "solid" matter behind any page of blocks, and in order to improve the appearance of the illustrations facing the leaders the columns of notes found a more or less permanent resting-place on the preceding page. That arrangement, with occasional lapses—on more than one occasion the relative positions were reversed so that the columns came opposite the leaders and the illustrations were on the previous page!—has been retained until now, when, the page of illustrations having been banished, there is no need to retain the columns so early in the paper. The headings of the columns remained unaltered until a year or two ago when they were changed to Road and Rail, Air and Water, and Miscellanea in order to cover a wider field.

In the earlier issues of THE ENGINEER a great deal of space was given up to the publication of abstracts of Patent Specifications, accompanied by very full lists of patents applied for and granted. But the great increase in the number of patents towards the end of last century caused the attempt to print full lists to be given up. The abstracts at first were not illustrated. Later only the lists of patents applied for and granted were printed, in company with illustrated abstracts of American patents. The publication of illustrated abstracts of British patents is relatively recent and is now to be given up for the "duration."

Although the Seven-Day Journal which fills the first page of each issue is not affected by our rearrangements, it may be of interest to our readers to learn how recent an acquisition it is. The whole matter must be within the recollection of older engineers. In 1907 a feature was started consisting in the first issue of each month of a review of engineering events during the preceding month. Each item was dealt with in a separate paragraph under an individual sub-heading. This feature, at each appearance, occupied the first page of the issue and overflowed into the following page. It was, however, the forerunner of the Seven-Day Journal only in the sense that it occupied the position that was later to be assigned to the Journal. The Seven-Day Journal itself did not make an appearance until so late a date as 1920—only twenty years ago. It was peripatetic, occupying any convenient page, usually in the front half of the paper, and the notes were short paragraphs with no individual headings. The first page of the first issue each month continued to be occupied by the Monthly Review. But in 1923 the Monthly Review was discarded and the Seven-Day Journal was assigned to the opening page and given an arrangement with a single-column main heading and separate sub-heads for each paragraph similar to that originally adopted for the Review. It was only three years ago that the Seven-Day Journal attained its present arrangement with a three-column heading.

Brief reference may also be made to two other "features." "Current Prices for Metals and Fuels," the usefulness of which largely evaporated when the Government took over control, so that it is no longer a weekly feature, originated in the very first issue of THE ENGINEER, taking up less than half a column of small print. But it was later dropped and was not revived until 1920, when a whole page was devoted to it. "Markets, Notes and News" is a very new feature, having only been started in 1933. It was preceded by "Provincial Letters," which it superseded. The "Letters" consisted of lengthy notes provided by correspondents in Lancashire, Sheffield, the North of England, &c., and had developed out of "Metals and Manufactures in the Provinces," a contribution from "Our Own Correspondent" in the last issue of March, 1856.

Literature

Applied Economics for Engineers. By BERNARD LESTER. London: Chapman and Hall, Ltd. 1939. Price 24s. net.

A GOOD many young engineers seem to have the impression that they are only concerned with the technical and academic side of their profession, thinking that if they take their degree and perhaps have a year or two in the works they will be in a position to regard themselves as fully trained. Some of our colleges appear to share this view, and even if they arrange lectures on the business side of their subject, these usually fall outside the recognised curriculum. A few moments' consideration will convince the engineer that he must be conversant also with the economic side of his calling, involving as it does not only finance, but also many social and psychological problems. The necessity for providing a clear approach to this complex subject is felt as much in the United States as in this country, for the author, writing from the American standpoint, affirms that he has "been impressed with the importance not only of a clear understanding of economic principles, but also the application of these principles." In a work covering such a wide field it is obviously impossible to go into great detail, but the relative importance of each branch and how branches are inter-related is carefully sketched, and the study of this comprehensive work should qualify the intelligent student to obtain a clear conception of the subject, enabling him to pursue matters further at a later date.

The subject is introduced by a general discussion on the position of the engineer in industry, followed by an explanation of the necessity for careful planning, and how it should be undertaken. We are then introduced to the human side of the business and the value of harmonious public relations. Mr. Lester does well to stress the importance of friendly methods and an understanding attitude, before he proceeds to the actual organisation of the business, with brief descriptions of the different methods. Certainly functional organisation is doomed to failure if the human outlook is unsatisfactory. It is natural after dealing with main principles of organisation to discuss the bearing of standards and standardisation, which may have

considerable influence on the economics of a concern, provided standardisation does not lead to stagnation—an even balance must be preserved. The broad principles of costing and accounting are briefly explored, after which the main requirements of the user are depicted, while the problems of the supplier, including development, production, and purchasing are satisfactorily explained. Attention is next devoted to marketing, distribution, and selling, and after dealing with these important subjects, the author again reverts to the human side, giving a chapter to the engineer as a citizen, clearly depicting his duties towards his fellow-men. The contention that a busy engineer will not find time to develop his interest in social, political, and economic matters is met by the statement that "almost invariably men with the greatest responsibility find time for the greatest activity." We agree, and are also interested in the author's conclusion that "the engineer of the future is going to make tremendous strides in this matter of studying human beings, and . . . when he does so will become the industrial manager of the world." An informative work concludes with a chapter devoted to twenty specific economic studies in different branches of engineering.

From the foregoing survey it will be apparent that no section can be treated exhaustively—indeed, this is not the intention of the author—but the whole problem is set out very clearly, and the book should prove valuable to a young engineer who aspires to leave the rank and file and become a leader.

We consider that Mr. Lester has done well to emphasise the importance and the value of good records, for too often in Britain this is a side to receive scant and grudging attention. Reading between the lines, we see the desire to inculcate in the student the habit of making his own records, thinking for himself, and weighing up the situation after marshalling all the known facts. From a number of instances cited, one is worthy of special note, that of the late Mr. Rockefeller watching the intricate machine that was used to solder on the tops of filled oil cans. His keen interest was explained when he said he had been counting the drops of solder used on each can, which proved to be thirty-nine. He then asked the question whether anyone had tested the machine to ascertain the exact number of drops required. Nobody had! Investigation followed, which proved that while thirty-seven were not quite enough, thirty-eight would give as good a result as the thirty-nine used previously. The saving of this one drop was worth 50,000 dollars per annum to the company. The power of observation is of infinite value, and fortunately it is one that can be developed, but another oft-time neglected principle is briefly expressed in the words of Thomas Edison, addressed to the coming generation of engineers: "The first thing is to find out everything everybody knows about a subject and begin where they left off." This is easy to say, but unless a firm maintains adequate records, it is a hopeless task for the young engineer to ascertain the extent of previous researches on the subject he has in hand.

We are particularly interested in the way in which Mr. Lester writes as if it were a foregone conclusion that the man who is responsible for selling engineering products is himself an engineer. Too often in this country when a salesman is expatiating on the virtues of the articles he is trying to sell, we elicit the remark: "Of course, I am not a technical man." We marvel at the "of course," and get no further in the business! Young engineers are prone to cavil at the importance attached to the office and its organisation, and the author probably has this in mind when he states that "selling has often been looked upon as an extra and unnecessary function, which increases the cost of the product to the user," but he proceeds clearly and logically to demonstrate its necessity, and in a similar way explains the value of other functions.

We are not in agreement with him in his condemnation of straight piecework, for if properly applied it should be among the most equitable methods of remuneration, but we should always qualify it with a guarantee of a minimum day work wage. Certainly many British workmen view with extreme disfavour some of the premium and other systems which appear to be more acceptable across the Atlantic.

SHORT NOTICES

Industrial Plastics. By H. R. Simonds. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 22s. 6d. net.—This book is intended as a source of information on plastics for the user and the prospective user of mechanical and structural materials, and for this reason the author has, so far as possible, avoided being too technical for the average reader. A general introduction is followed by particulars of the basic materials which enter into the production of plastics. Full details of ten important plastics: phenolics, acetates, nitrates, ureas, styrenes, vinyls, indenes, acrylates, casein plastics and furfurals—their properties, manufacture and applications are given in one comprehensive section. Later chapters cover moulding practice, fabrication, physical properties, equipment and plant, applications, design, chemistry, &c. An interesting section on research and the future of plastics deals with some new applications, future possibilities and some typical research problems. Although particularly concerned with American practice a brief chapter is included on the industry and its applications in various other countries. This book has obviously been prepared with considerable care and will be found a valuable guide by all students and others interested in this rapidly growing branch of industry.

Hoisting Machinery. By W. H. Atherton, M.I. Mech. E. London: Technical Press, Ltd., 5, Ave Maria Lane, E.C.4. Price 32s. 6d. net.—This book covers the design and construction of a wide variety of cranes, derricks, skip hoists, stackers, telphers and transporters. In addition to the chapters on each particular lifting or hoisting appliance, auxiliary gear such as drums and pulleys, chains and ropes, hooks and bottom blocks, spur gears, slings, skips, grabs and lifting magnets are dealt with in separate sections. The descriptions are supplemented by a large number of illustrations and drawings.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents.)

TRAINING OF LABOUR

SIR,—Government training centres, which you have described so fully, are of great value. Experience with those already established has proved their efficiency and many men who have passed through these centres are now employed in war work to their own satisfaction and with great advantage to the national output. The courses laid down for training in these centres are thorough and excellent for peace-time conditions, but they are too ambitious, too elaborate, and take too much time to serve our present need, which is for the rapid and wholesale training of unskilled men and women, not to be engineers, for that cannot be done in the time available, but to carry out simple repetition work with speed and efficiency.

The leading article in your current issue rightly emphasises that complexity must give way to simplicity in the design of machines, because of the urgency of the time element, and this holds good equally in the training of labour. It is understood that this fact has at last been accepted by the Government training centres and that their course has been simplified, so that the training, though less complete, will proceed much more rapidly.

But, in any event, the new training centres which are to be set up cannot produce results for some time, and must therefore form part of the long-term programme. The short-term programme, on which we must perforce concentrate, demands labour now, and if we are to get this labour it must be trained by each employer in his own factory. For many reasons this method is preferable; the training can be introduced at once in those establishments where it has not already begun; it can be expanded almost indefinitely in those works which have already adopted it; it can proceed by night as well as by day; each learner can be taught to do the particular job which he or she will have to do, and can consequently begin actual and useful production after a few days' instruction. Instructors are already available in the foremen, charge hands, and operators in the factories. There is no better way than to attach a learner to an operator who is already doing the job. After watching for a short time and hearing brief explanations as the work goes on, the learner is encouraged to try, and, if keen and reasonably intelligent, progress is rapidly made and the learner can be put on to a machine.

Progress is generally satisfactory under these methods, and very soon the learner of to-day becomes the instructor of to-morrow.

Working on a broad front throughout the factories of the country the results are rapid beyond the belief of critics, who so often live in the clouds of theoretical ideals or in the mud of prejudice.

Remember always we have no time to train engineers, but we can increase the field covered by our skilled workers by confining them to skilled work and by letting the new labour take over the thousands of simple jobs on which so many of our skilled workers are still wasting their time. The necessary machinery is already in the factories, the material and the tools and gauges are available.

Those who have had experience in this type of training know that women learn just as quickly and make just as good operators as the opposite sex, limited only by their physical capacity, which should never be overstrained. They are, moreover, more tolerant of monotonous tasks, and realising, as they do, that they are helping to save their menfolk, they not only work diligently, but with a smile.

ALFRED HERBERT.

Whitchurch, Hants, June 28th.

Sixty Years Ago

EXPLOSION OF A RASTRICK BOILER

ON May 15th, 1880, a Rastrick boiler exploded at the Birchills Ironworks, near Walsall, killing twenty-five people. The boiler was about 10ft. in diameter and 26ft. long, with rounded ends. It was set, with its length vertical, at the centre of a group of four puddling furnaces, the flue gases from which, after passing round the lower half of the boiler, entered four 2ft. diameter cross tubes, which conducted them to a central internal flue, whence they were discharged at the lower end of the boiler into a horizontal passage entering the base of an adjacent chimney. The working pressure was nominally about 41 lb. The boiler exploded with great violence. Fragments were scattered in several directions, but the main portion, comprising substantially the whole of the upper half, the four cross tubes, and the central internal flue, was flung 120 yards across a canal. A coroner's inquiry was held into the circumstances of the accident. In our issue of July 2nd, 1880, we reported and commented upon the jury's verdict. That verdict, we held, was not entirely satisfactory. It asserted that the boiler had been subjected to hard firing day and night, that several of the plates had been weakened by corrosion, that the boiler had been repeatedly repaired, and that the safety valve area was too small for the diameter of the boiler. The jury also asserted that the boiler had not been managed by a competent engineer, that steam and water indicators were either wanting or were incorrect, and that the owners were to blame for using the boiler after they had been repeatedly cautioned by the Boiler Insurance and Steam Power Company, of Manchester, with whom it was insured. Our comment on this verdict was that it bore evidence of having been drafted by the foreman of the jury, a man who, it seemed evident, only began to learn the first principles of boilermaking during the course of the inquiry. It was a curious feature of the accident that an inspector in November, 1879, had found the boiler working at a pressure of 33 lb., although certain of the lower plates had wasted away to a thickness of $\frac{1}{8}$in. The defective plates were all removed and replaced, yet the repaired and ostensibly stronger boiler exploded under a pressure little greater than that withstood by the boiler when defective. Searching for the true cause of the explosion, we noted that in an attempt to stop the boiler from priming, someone had altered the position of the float controlling the level of the water in the boiler, with the result that the water level had fallen about 2ft. below the normal position. This fall had lowered the water level to a point just above the cross tubes—the weakest section of the boiler shell. Above the water level a portion of the shell within the brickwork setting was directly exposed to the flue gases without a water backing. It was evident therefore, we said, that the boiler exploded because the shell plates above the water level had been weakened through the loss of strength which accompanied the considerable rise of temperature to which they had been subjected. . . . In our succeeding issue we published a letter addressed to us by the foreman of the coroner's jury, in which he took exception to our implication concerning his knowledge of boilermaking. He had, he said, been a millwright and engineer all his life, as had been his father before him. He challenged our calculations on the strength of boilers and persisted in asserting that the Walsall boiler failed because it was badly designed. To illustrate his remarks on this last-named point, he asserted that the exploded boiler had been made sixteen years previously by a man who in his evidence before the coroner admitted that neither he nor his son—also a boilermaker—could read or write, and that his bills were made out to his dictation by his daughter. It was obvious that such a man could not make any calculations whatsoever in connection with his work.

BOMBAY PORT CLOSED.—It has been officially announced in Simla that the Port of Bombay has been temporarily closed to shipping. All other Indian ports are open.

Contraction in Grey Cast Iron*

By E. LONGDEN, A.M.I. Mech. E.†

THE term "contraction in cast iron" is used in this paper to define the reduction in volume which operates from the point of solidification to atmospheric temperature. Reduction in volume from casting temperature to the point of solidification might well be defined as "shrinkage," although both terms are used to describe a diminution in volume.

The amount of contraction and degree of distortion in a casting will have relationship to the chemical and physical properties of the metal, design, and method

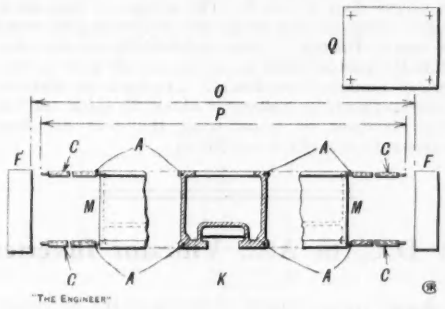

FIG. 1—*Method Used for Ascertaining Volume Changes*

of manufacture. Factors influencing contraction include:—

(1) Chemical composition of the alloy.

(2) Melting conditions, pouring temperature, and superheat of the metal.

(3) Design, section, and volume related to section.

(4) Size, shape, location, and distribution of runner and riser gates.

(5) Character of the mould and core materials and their condition when the metal is poured into the mould.

(6) Method of moulding and core-making.

It is not intended to detail the influences stated above, but to offer further information about the behaviour of castings during cooling. In the past, standard contraction has been laid down for cast iron, irrespective of its very varied constitution, or size and design of the casting.

It is well understood that the composition of an alloy should be suitable to the class of casting, but control of composition for the majority of castings will not eliminate substantially the vagaries of contraction with its incidence of distortion and stress. The design, size, and mass of castings must command consideration.

Little attention has been paid by investigators to the effect of volume changes on castings of a commercial character. Consideration has been given to cast iron as an alloy. One has to turn back to the experiments of Professor T. Turner, carried out in 1906, and even earlier investigators, such as Mallet and Keep, for any definite findings on contraction. All such experiments, however, were carried out on test bars of simple form.

Because a large casting offers a wider and bigger field for observing movements during cooling than small castings or test bars, the author's attention has been directed to following the movements of large castings during cooling.

Volume Changes.—Arrests in the rate of contraction or an expansion at critical temperatures are quite pronounced in the general run of cast irons. Such volume changes would appear to be largely due to the liberal amount of carbon present in cast iron and its condition. The precipitation of primary graphite on solidification, and secondary graphite at lower critical temperatures, will account for expansions.

According to Professor Turner, phosphorus is responsible for an expansion, if present in appreciable quantities. Generally, it has been considered that there are two distinct arrests in low-phosphorus irons, and, in alloys with appreciable phosphorus content, three arrests.

The final amount of contraction will be influenced by the ratio of free carbon to combined carbon in the completely cooled casting, but the data presented in this paper will indicate that final contraction and the absence or presence of stresses in many classes of castings are also due to the conflicting expansion and contraction influences operating together in the same casting. In lengthy castings, mould and core resistance will tend to reduce contraction and create stressed material.

Test Procedure.—A method devised by the author for ascertaining the behaviour of large castings during cooling, from the point of solidification to atmospheric temperature, is illustrated in Fig. 1. The movement of the casting is followed by frequent measurements between fixed points outside the mould and rods held by the metal of the casting. Whenever practicable, temperature readings are associated with the volume changes.

The example chosen to describe the procedure is that of a lathe bed. A cross-sectional elevation K and two end portions of the longitudinal elevation M are outlined in Fig. 1.

The test procedure is as follows:—During the ramming of the moulds, heavy weights F (Fig. 1) are located soundly below the floor level, outside the ends of the pattern at a suitable distance (in this example 3ft.). Wrought iron tubes C, 2ft. 8in. in length, are also positioned and rammed around with the rest of the mould. The tubes are placed with ends within 1in. of the vertical faces of the casting, and the opposite ends about 4in. away from the machined vertical face of the weights F. Four tubes are located at each end of the mould, two opposite the heavy slideways and two 2in. from the top face of the mould. Each tube is fixed opposite the vertical walls of the casting. There are thus eight tubes.

Following the withdrawal of the pattern and the finishing operations, the moulds are broken through to the tubes and ¾in. wrought iron rods A are pushed forward to within about 3in. of the face of the heavy weights F, at each end of the mould. About 1in. of the rod A, made jagged to hold fast to the metal of the casting, penetrates into the mould cavity. The opposite ends, which have been ground perfectly flat, correspond with crossed centre lines scribed on a polished section of the weight opposite (see Fig. 1, Q). The spaces between the ends of the tubes and the mould face are well sealed and secured by ramming sand around the rods now leaving, as before stated, the ends of the rods protruding into the mould cavity, to be gripped by the metal of the casting.

Just before pouring the casting, careful measurements are taken by inside micrometers of the gap between the ends of the rods and the centres marked on the weights. Provision is made to begin taking measurements within three minutes after pouring the mould. In the case of a large castings, repeated measurements proceed at intervals of three minutes for about three hours, when the measurements are slowed down to every fifteen minutes for a further five to six hours, then every half-hour for about six hours, every three hours for twenty-four hours, and checking is continued four times daily until contraction is complete. The total contraction is shown by the final gap distance between the faces P of the rods A and the faces O of the weights F, less the original gap dimensions before pouring the casting. The sum of the net dimension at each end equals contraction.

The alterations between the points O P indicate, with a closing of the gap, expansion, and, with a widening of the gap, contraction. The records of the movement of the casting with associated times are plotted on graphs. The early behaviour of the casting is expressed in minutes and the complete movements in hours.

A line, zero, on the graphs identifies the condition of the molten metal in the mould. The penetration of the curves below the zero line indicates expansion beyond the size of the mould. Above the zero line the curves register contraction, and any further volume change, such as expansion or arrests. Note is taken of the expansion of the test rods due to absorption of heat from the casting. The temperature variations of the rods are checked at intervals. Later, the same class and length of rod is heated to a similar temperature as obtained during the cooling of the casting. The length of the rod, cold, as against the rod heated to the particular temperature required, gives the amount of extension of the rod, which must be cancelled from the early movements of the casting as recorded. A further adjustment is needed in castings which are cambered. On the total contraction, an allowance is made for the difference in length that a curved line will give when straightened out.

TESTS ON LARGE BORING BAR CASTINGS

The volume changes of a large solid boring bar, 18in. diameter and 45ft. in length and weighing 15 tons 15 cwt., are illustrated by the cooling curves in the graph, Fig. 2.

The casting, on account of its great length, is poured in a horizontal position. A description of the moulding technique would be too lengthy to include in this paper. Briefly, the mould was metal-faced and of special construction, which produced an excellent quality casting. The composition of the metal is shown in Fig. 2.

A record of the movements of the casting was obtained in a similar manner as by the general method of obtaining volume changes described earlier in these notes. Two readings were obtained from two rods located one on each end of the mould. The sum of the movements was plotted in the graph, Fig. 2. All allowances have been made in the curves for the expansion of the test rods due to rise in temperature. This adjustment also applies to the curves of the 22in. cored bar, a description of which follows the first example.

The minutes' curve shows an arrest at ten minutes when the casting is substantially solid. Expansion is indicated for about 65 minutes. Zero is reached in 170 minutes; contraction proceeds for a period until 570 minutes is reached, when a very decided arrest and expansion is registered which lasts for 330 minutes. A further arrest follows at 980 minutes, but it is of short duration and lasts about 25 minutes.

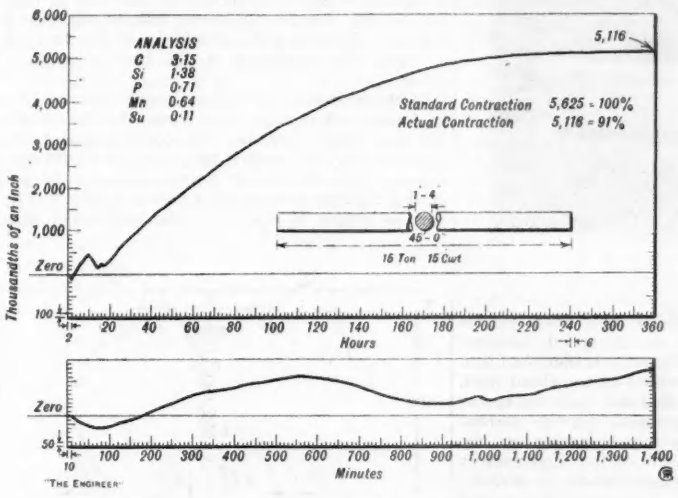

FIG. 2—*Volume Changes of Solid Boring Bar*

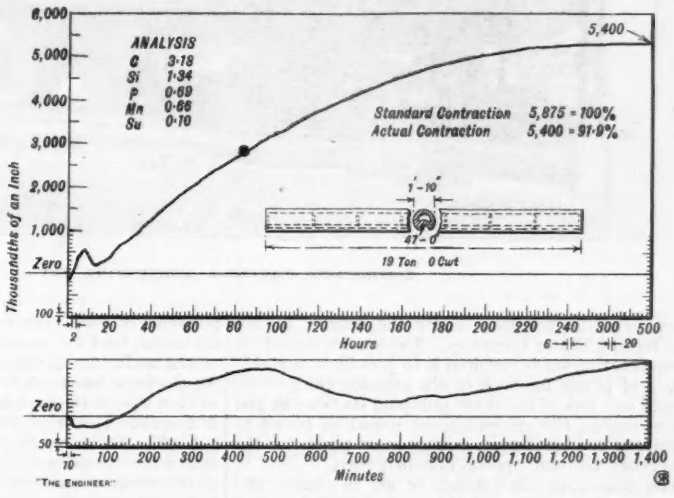

FIG. 3—*Volume Changes of Cored Boring Bar*

From this point the curve indicates only small fluctuations and a steady rate of contraction. The curve in hours shows the complete behaviour.

Finally, on cooling to room temperature, the total contraction is found to be only 91 per cent. of standard allowance at 5116 thousandths against 5625 thousandths. The casting had taken up 96 per cent. of its contraction in ten days.

A second test, applied to a cored boring bar, 22in. diameter and 47ft. in length and weighing 19 tons, confirmed the tests applied to the 18in. solid bar. Fig. 3 shows the design and dimensions of the bar, and the cooling behaviour of the casting by the curves plotted on the graph.

The casting was made and poured in a similar manner as practised for the solid bar, but with the added complication of a series of kidney-shaped cores, which were almost completely surrounded by metal. Again, a truly sound and satisfactory casting resulted from the technique employed. The composition of the metal is set out in Fig. 3.

The minutes' curve indicates an arrest and expansion at 10 minutes when solidification of the metal is well advanced. Expansion continues for about

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* The Institute of British Foundrymen.

† Manager, Foundry and Pattern Shops, Craven Brothers, Ltd., Machine Tool Engineers.

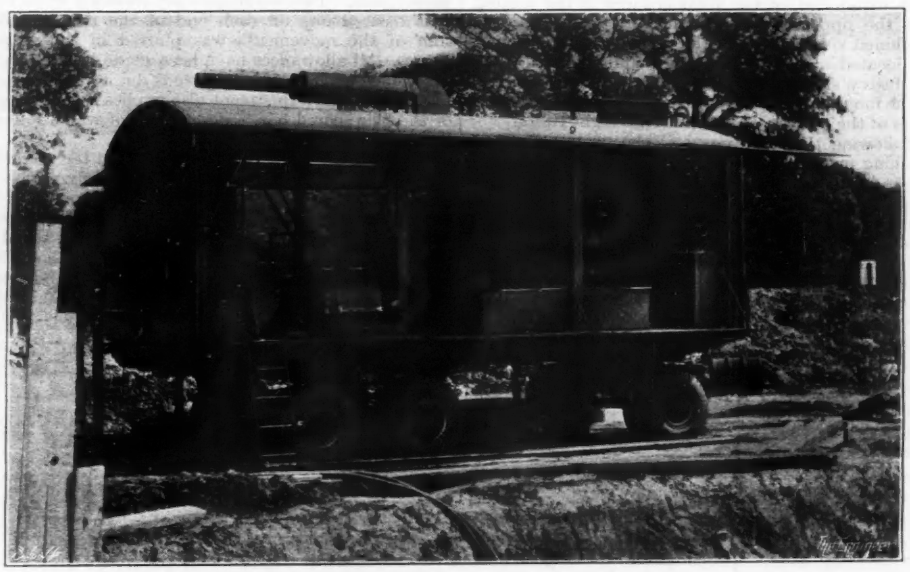
60 minutes. Zero is reached in 130 minutes. A short arrest is disclosed at 285 minutes. After further contraction a most marked arrest and expansion is registered in 440 minutes. This volume change lasts for 320 minutes, until 750 minutes is reached. A further small arrest can be noted at 850 minutes. From this point the rate of contraction is very uniform. The hours' curve shows the completion of the cooling process of the casting. After cooling down to atmospheric temperature, the total contraction of the casting was 5400 thousandths against 5875 thousandths for the standard allowance. Contraction equalled 91·9 per cent. of standard allowance. The casting had taken up 94 per cent. of its contraction in ten days.

(To be continued)

Portable Generating Set for Emergency Pumping Duty

IN the accompanying engraving is shown a 150-kW portable oil-engined generating set of interesting design, which has recently been completed for the Mid-Wessex Water Company. This set is intended for standby pumping duty, forming part of the A.R.P. measures taken by the company to safeguard water supplies under its control, and was built by John Fowler and Co. (Leeds), Ltd., to the specification of Mr. Claude Pain, M. Inst. C.E., the managing director and chief engineer of the water company.

Under its A.R.P. scheme, the company has installed standby pumping equipment in the form of a bore-hole pump, electrically driven, at each of three of its main pumping stations. These stations have been selected as being the best locations from which adequate emergency water supplies could be kept



EMERGENCY PORTABLE GENERATING SET

going over the territory under the control of the Mid-Wessex Water Company. The service for which the generating set is required is to provide a portable source of power for each of the standby pump sets. Should any one of the three pumping stations be put out of action, the generating set would be towed to the site of the breakdown and generate power for the emergency bore-hole pump installed there.

The generating set consists of an oil engine and generator mounted together in a six-wheeled trailer, approximately 19ft. 9in. long, 8ft. 6in. wide, and 12ft. 6in. overall height, with the height of the trailer platform approximately 3ft. 6in. The trailer is of the low-loading type, designed and manufactured by Fowlers. The engine and generator are mounted on a sub-frame, which is three-point suspended in the main frame of the trailer. This arrangement is designed to give a low centre of gravity and good balance to the whole trailer.

It will be recalled that in our issue of March 10th, 1939, we fully described and illustrated one of a number of such sets manufactured for the Metropolitan Water Board. The set illustrated herewith appears to be substantially similar in arrangement.

The engine is a six-cylinder Fowler-Sanders unit, rated at 225 B.H.P., to give 150 kW at 1000 r.p.m. at the generator terminals. It is designed for heavy-duty work and is claimed to be capable of maintaining its rated output for long periods without the necessity of skilled attention.

A feature of the design is the attention which has been given to the dustproofing. All moving parts are totally enclosed and run in oil, while as a further protection against dust-laden atmosphere, such as portable equipment is often called upon to meet, a battery of four Handy oil-wash air cleaners is mounted and is connected by manifold to the air inlet on the cylinders.

Cooling is by fan and radiator, the radiator being a multitubular block with cast steel sides, top, and bottom tanks. The fan is a "Sirocco" type driven by belt from the engine crankshaft. Behind the fan is mounted a metal cowl to divert the air upwards and out of the trailer.

Coupled to the engine through a flexible coupling is a Crompton Parkinson compound-wound interpole drip-proof D.C. generator, having a continuous output of 150 kW at 230 volts D.C., at a speed of 1000 r.p.m.

An auxiliary battery-charging set is provided for charging the starter batteries of the engine. This set comprises a radiator-cooled 4 H.P. Fowler petrol engine, running at 1500 r.p.m., directly coupled to a Crompton Parkinson shunt-wound battery-charging generator. Engine and generator are mounted together on a steel frame secured to the main frame of the trailer. On an extension of this steel bed-plate is mounted a single-cylinder air compressor which is coupled to the petrol engine through a combined clutch and "Bowden" control. This small air compressor is included for inflating the pneumatic tyres fitted to all trailer wheels.

Mounted at the rear of the trailer is a cubicle type switchboard, manufactured by Brookhirst Switchgear, Ltd., which carries all essential instruments and controls, and, in addition, a ratchet type motor starter. On each side of the cubicle is mounted a hand-operated cable drum, each carrying a 60ft. length of flexible cable. A "Niphan" water-tight socket is fitted at one end of each cable for connection to the pump motor, while at the other end of the cable is fitted a "Niphan" connector plug for connection to the socket provided on the switchboard. Both cable drums are mounted in pedestal type bearings, carried on a mild steel framework and permanently mounted on the trailer. Each drum has a locking device enabling the drum to be secured at different positions of each turn. A third cable drum carries the shunt lead to the motor, so that speed variation on the motor can be effected from the trailer platform. An electrical interlock is provided on the shunt lead, so that should the lead be pulled out while the motor is running, the trips are operated and the current cut off. By arranging the motor starter on the trailer it is possible to start any of the three motors at the above-mentioned pumping stations, thus doing away with individual starters and so reducing capital outlay.

In addition to the instruments and switchgear for the main generator, the cubicle also houses the battery-charging gear, a change-over switch from the main generator to the auxiliary petrol-engine-driven battery-charging generator, and a voltmeter and ammeter for the batteries.

The pumps installed at the three pumping stations mentioned above are Harland "Spiroglide" units, manufactured by the Harland Engineering Company, Ltd., and are vertical-spindle, multi-stage, deep-well, centrifugal pumps with rated output of 1000 gallons per minute against a total head of 434ft. Each pump is driven by a Harland vertical-spindle, screen-protected, shunt-wound D.C. electric motor, wound for 230 volts D.C. supply, and connected to the pump by flexible coupling. The motor terminal box is fitted with "Niphan" plugs to receive the trailing cable and shunt lead. Each set is mounted on specially prepared foundations, with connections to the pumping mains ready for immediate use.

The trailer was specially designed to suit the specified equipment, and load distribution to the axles was given special attention. All axles are interchangeable, the two rear axles being fitted with brake drums. Brake rods are used in preference to cables, and the brake gear is fully compensated on all four rear wheels. The brake gear is operated either by hand wheel from the side of the trailer or through a cable from a towing vehicle. Semi-elliptic laminated springs are fitted, springing being fully compensated on the rear axles. Four screw jacks are permanently fitted on the main frame at front and rear respectively, and are used when the set is in operation.

The trailer is designed so that it can be totally enclosed if required. The roof is of galvanised sheet steel with rolled guttering and riveted laps, and is held by eight channel section stanchions. The sides are split into three sections, each section forming a door made to swing up, hinged at the top, and provided with rigid stays. To one side of the radiator an access door is fitted. The weight of the whole trailer complete and ready for service is just under 18 tons. Towage is accomplished by means of a 40 H.P. tractor hired by arrangement with a local firm of haulage contractors. The furthest distance between pumping stations is about 25 miles and the time occupied in transferring the unit at short notice is from eight to ten hours.

A D.C. to A.C. Vibrator Inverter

A NEW type of vibrator inverter for the conversion of D.C. to A.C., and suitable for small outputs, has been introduced in America. Long contact life is ensured by reducing the current to zero before the vibrator contacts are opened, thus eliminating sparking. Frequency regulation is said to be excellent and the efficiency high. The principle will be understood from Fig. 1. If a reactor L, capacitor C, and resistance R be connected in series across a D.C. supply, as shown by the solid lines, an approximate sine wave half-cycle current will be obtained. The extent of continued oscillation will depend upon the damping of the circuit resistance R. Assuming the capacitor to be completely discharged when the switch 1 is closed, the current will increase to a maximum and reduce to zero as the capacitor becomes fully charged.

If the switch 1 is opened at the point X on the current wave I_3, there will be no spark at the switch, since the current at that moment is zero, and the capacitor will be charged to a potential equal to the line voltage. When closing switch 2 the capacitor C will begin to discharge and force a current I_4 to duplicate the charging current I_3 in all respects, except that it will flow in the reverse direction. Again no spark will occur at switch 2 if it is opened at the point Y. As the capacitor and reactor have definite reactance constants, the currents I_3 and I_4 individually acquire the same definite resonant frequency. Providing the resistance of the two paths is equal, the amplitude of the two waves will be equal.

If the switching operations occur alternately and uniformly, alternating current can thus be obtained. For switching purposes, the conventional type of vibrator may be used if the respective contacts be made to open the circuit corresponding to the points X and Y in the current waves, as indicated in Fig. 1. The resistance R represents the load which should

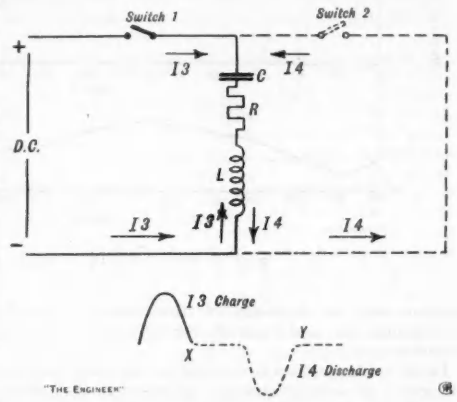


FIG. 1—CHARGE AND DISCHARGE CIRCUIT

be of the proper value to obtain correct damping of the load current. By omitting the reactor, the current will increase at a very rapid rate, equivalent to a high frequency, and the current will decrease in the same half cycle at a very slow rate, which would be equivalent to a low frequency and wave shapes of this type would be of little value for power purposes.

A new inverter circuit is made possible by the arrangement in Fig. 2. The circuit is similar to the charge-discharge circuit, Fig. 1, except that an output transformer has been added to couple the load resistance with the exciting source. Certain kinds of load may be supplied directly from a single low reactance transformer, excluding the use of a tuning reactor L. But this is only possible where a lagging power-factor provides the necessary inductive

reactance to operate in series with the capacity C to provide the correct resonance frequency. In other applications, such as that of operating neon tubes, the tuning reactance may be combined in a single output transformer by providing sufficient leakage reactance between the two windings.

General applications, however, usually require the inductance to be provided as a separate unit, and that the output transformer be of the conventional low reactance type with minimum leakage reactance between windings. Since the load current can be made to reduce to zero, an ideal time in the cycle is available immediately after each half cycle for the contacts to open the circuit to switch for the alternate half cycle. During the moment of no current flow the contacts may be opened without any trace of sparking.

It is essential to choose circuit conditions that will enable the load current to increase to a maximum and decrease to zero during a single closed period of one pair of contacts. To obtain maximum output

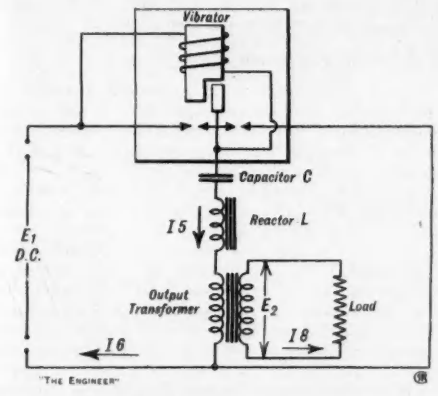
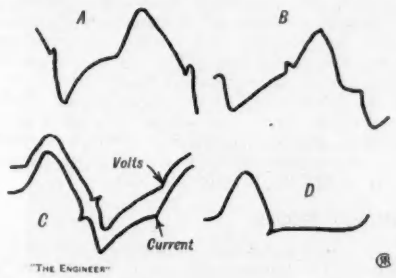


FIG. 2—INVERTER CONNECTIONS

load in watts, it is desirable to open the circuit as soon as possible after zero current has been reached. In other words, the load current should flow for as much of the time as possible. Uniform resonant frequency of the load current can be easily controlled by holding the reactor and capacitor reactance constant within definite limits. Constant frequency of the vibrator is made available at little extra expense, since the vibratory reed has that inherent characteristic. As in many cases a specific frequency is required, the frequency of the vibrator must be selected to meet requirements. The resonant frequency of the load current must have a value approximating 10 per cent. higher in order that the contact current is zero before the contacts open.

As the line current from the D.C. supply consists of charging current alone, the effect is a series of D.C. pulsations, exactly of the shape and amplitude as the positive half cycles in the oscillogram A, Fig. 3. Since line current from the battery flows only half the time, a D.C. ammeter measurement will be slightly less than half the A.C. measurement of current in the capacitor leg.

The oscillograms, Fig. 3, show at A the alternating current I_5 of the current circuit, Fig. 2, and consists of both alternate charge and discharge currents in



A—Alternating current I_5.
B—Output A.C. voltage E_2.
C—Relation of current I_5 and output voltage E_2.
D—D.C. line current I_6.

FIG. 3—INVERTER OSCILLOGRAMS

alternate arrangement. The oscillograms A, B, and C were taken with an inverter connected in accordance with Fig. 2, and connected to a 96 per cent. lagging power factor load. The following test data show actual relative measurements and are true for the conditions of the various oscillograms, viz., E_1 line volts D.C. 110, I_6 D.C. line current 1·4 amperes, E_2 (load volts) A.C. 107 (Fig. 3B), I_8 load A.C. 1·18 amperes, load watts 122, capacitor current I_5 3·68 amperes (Fig. 3A), capacitor C 124 microfarads reactor L 0·0241 henry. The oscillogram D shows the D.C. line current I_6.

Phase relation and comparison may be made of A.C. output volts E_2 with capacitor current I_5 by referring to Fig. 3C, where it will be seen that the wave shapes are quite satisfactory for most purposes, and from close inspection of the oscillograms (which are copies of the originals) it can be seen exactly where the vibrator contacts close and open.

The simplest method of starting the vibrator in motion is to connect the driver coil of the vibrator directly across the load contacts on the battery side. When closing the D.C. supply switch an initial current will flow through the transformer primary, capacitator and driver coil. Although this current is small, it establishes a directional flux to start operation of the vibratory reed in the usual manner. During the initial swing of the reed, the corresponding contacts close, and allow for the first half cycle of the charging component of the load current. Simultaneously the driver coil becomes short circuited to remove the magnetic pull upon the reed and allows the latter to swing back across the centre position to close the other pair of vibrator contacts. During this period the discharge half cycle occurs and since the short circuit has been removed from the driver coil, the reed is pulled in the opposite direction to repeat the continuous cycle. The natural frequency of the reed determines the A.C. frequency.

The A.C. electrolytic capacitor has proved most suitable for use with the apparatus, chiefly because of its small size and low cost. The A.C. output can be synchronised with an isolated A.C. power source by providing the driver coil of the vibrator with a suitable low voltage, obtained directly from the synchronised voltage.

An important feature is that which allows the D.C. supply current to reduce to zero if the vibratory reed should stop in any position of its normal operating range while the D.C. line switch remains closed. Since the capacitor becomes charged and remains charged, no current can flow. The battery or D.C. circuit is opened if the discharge contacts remain closed.

At present much hope is held out for the application of the inverter for use with the standard 110-volt A.C. television receivers in D.C. districts, for the frequency is constant and there is no disturbing interference.

The original purpose of the apparatus was to provide a cheap supply for neon signs on motor vehicles. For this purpose a circuit corresponding to Fig. 2 may be used, except that the output transformer requires sufficient leakage reactance between the windings to hold the tuning reactance within reasonably close limits to prevent contact sparking for the various load conditions. An inverter suitable for most neon sign application for 6-volt D.C. service supplies 7500-volts open circuit, which is suitable for 10ft. of 9 mm. diameter red neon tubing. The battery discharge is almost constant at 3·5 amperes for any load condition. For this purpose an electrolytic condenser of 6500 microfarads is necessary. Owing to the favourable wave shapes, the smoothness and appearance of the tubing while operating are comparable with that operated with any normal commercial A.C. supply.

With the aid of this inverter the problem of supplying suitable A.C. power to a group of the new fluorescent Mazda lamps from 32 to 64 volt batteries appears to be solved. Throughout the normal variation of the battery voltage, an efficiency of 75 per cent. is maintained. The best operation is obtained with a load power factor near unity, although leading or lagging conditions may be tolerated. Several railway cars in America have now been equipped with fluorescent lights and vibrator inverters. With no changes to the batteries and generators of existing equipment, it has been possible to increase the average illumination on the reading level from approximately 3 foot-candles with tungsten lamps to approximately 11 foot-candles with fluorescent lamps.

The constant frequency of the inverter power supply becomes a valuable feature, since the lamp auxiliary is of the reactance type. Even with battery voltage variations from 28 to 43 volts, the vibrator has been made to hold almost constant amplitude of the vibrator reed and to provide almost a constant frequency of 60 cycles per second. Hence with a constant frequency of the power supply the voltage may be allowed to vary to some extent without causing damage to the auxiliaries or to the fluorescent lamps. It is possible to eliminate the lamp regulator which has been necessary for tungsten lamps on railway cars.

At present the rated outputs from 32-volt sources has not much exceeded 250 watts and for loads of 1000 and 1500 watts panels of four and six sections have been used. Each 250-watt section is connected to a group of from twelve to sixteen lamps, as required. It is evident that the present output can be increased, although it is believed that standardisation of ratings may establish the 250-watt size.

The apparatus is described in a paper by Mr. O. Kiltie, presented at the American Institute of Electrical Engineers, and the foregoing is an abstract.

INCREASED ELECTRICITY CHARGES.—We have received from the Electricity Commissioners a copy of a tabular statement which has been prepared for the Minister of Transport showing the increases which have been made in charges for electricity by authorised electrical undertakings in this country since the beginning of hostilities in September last.

American Aircraft Types

A FEW types of military aircraft from the United States have already become familiar in this country through their use in the air services of the Allies. Probably the best known are the Lockheed Hudson reconnaissance aircraft adopted early in the war by the R.A.F. Coastal Command, and the Curtiss Hawk 75 A fighters of the French Armée de l'Air. Both are straightforward designs whose features are strength and power of manœuvre rather than high speed. But there are a number of other types of U.S.A. aircraft not yet so well known, some of which are rather less conventional in appearance and design, and which may have interesting possibilities in war.

Among the twin-engined fighters is a single-seat 400 m.p.h.-plus machine with superfine streamlining, the Lockheed P-38. A characteristic feature is the way in which the two engine nacelles are extended to form the tail units, and a central fuselage dispensed with. The engines are 1250 H.P. Allisons, an in-line type of liquid-cooled unit reminiscent of the Rolls-Royce Merlin. Allison is a relatively new name in U.S.A. engines, and the type is now fitted to a number of America's newest fighters. Another interesting American is the Bell Airacobra, a single-seat fighter for which a speed of over 400 m.p.h. is also claimed. In silhouette not unlike the British Spitfire, it is unique among contemporary aircraft in mounting the engine amidships, behind the pilot, and driving the airscrew by a long extension shaft. Another Bell product is the twin-engined, multi-seat Airacuda, in which the propellers are fitted behind the wings. Forward extensions of the engine nacelles are used to house gunners.

A more conventional type of single-seat fighter from which a high performance may be expected is the Curtiss P.40. This sturdily built fighter, designed for the U.S. Army, is also powered with a single 1250 H.P. Allison motor. The latest version is known as the P.40.D. The wing span, 37ft. 4in., is just a little more than that of the Spitfire. Another interesting design is the little, high-powered Vultee Vanguard. Although only a single-seater, with a wing span of 36ft., it houses a 1600 H.P. Pratt and Whitney engine under its cowling. For fleet work the Americans have a useful four-gun fighter in the Brewster F 2 A-1. This has an air-cooled Wright Cyclone engine of 800 H.P. Its short chubby fuselage and stiff wings give it a distinctive appearance, rather like a flying barrel. Not much information has been released about the armament of these new fighters. In general, U.S.A. aircraft are less heavily armed than their British counterparts, but it may be remembered that the fire power of the Curtiss Hawks supplied to the French Air Force was increased to meet modern war requirements.

America's new type bombers include a number of fast, medium-sized, twin-engined types with a useful range. Some are fitted with diving brakes and other devices for close attack duty, and are known as attack bombers. The Douglas B-23 is an interesting example of American bomber design. Fitted with two Wright Cyclone engines, it is claimed to have a speed of 375 m.p.h. This is some 75 m.p.h. faster than the British Blenheim, a somewhat comparable type. An earlier type of Douglas, the D B-7, has much the same characteristics, but a lower performance. Its wing span of 60ft. is about midway between that of the Bristol Blenheim and the Handley Page Hampden. Another good U.S.A. bomber is the Glenn-Martin 167-W, which has seen considerable service with the French Air Force. Not so fast as the new Douglas—315 m.p.h. is about the maximum it can do—it is nevertheless a generally useful type, being designed not only for bombing, but also for fighting, reconnaissance and ground attack work.

Besides fighters and bombers, America also produces a number of trainer aircraft and flying boats. The North America Harvard trainer was one of the first U.S. aircraft to fly the R.A.F. colours, several hundred having been bought before the war. So far, no flying boats have been in service with the R.A.F., except for experimental purposes. Among the American flying boats those constructed by the Consolidated concern are perhaps the most well known.

Pre-Selective Discharging Conveyor

To serve the ever-growing need for greater flexibility in mechanical handling, sorting and distributing demanded by modern industry, the New Conveyor Company, Ltd., of Oldbury, Birmingham, has developed the "Selectatrip" system, illustrated by the accompanying engravings. This system is intended primarily for the handling or sorting of packages, loose parts or bundles, &c., and consists essentially of an overhead trolley conveyor fitted with pre-selective devices at each load carrier, by means of which the load may be discharged at any point along the conveyor system pre-selected by the sender of the goods. The discharge stations along the conveyor system each consist of a simple malleable iron cam or ramp fixed to the underside of the con-

veyor track. Between the chain and track cam a follower is pivoted on the trolley arms, the rear end of this follower or shoe being in contact with a push rod which when depressed by the action of the cam actuates the mechanism in the "Selectatrip" box. When a carrier reaches its pre-selected station the movement of the mechanism is transmitted by means of a Bowden cable to the tray tipping lever, which in turn unlocks and tilts the tray, thereby discharging the load. In Fig. 1 the carrier is illustrated approaching a discharge point on the horizontal portion of the track, and in Fig. 2 the tray is in the tilted position.

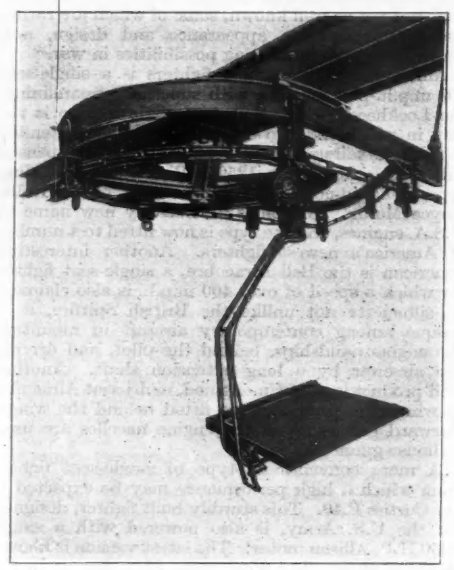


FIG. 1—CARRIER APPROACHING DISCHARGE POINT

As the discharging carrier leaves the selected station the tray returns to a horizontal position and is automatically locked ready for reloading.

The selecting mechanism is composed of machined parts working in a dustproof cast iron case. The lower half of the case forms an oil sump, and a splash system is employed to ensure perfect lubrication. An indicator window is formed in the front of the case adjacent to the dialling handle, and affords a clear view of the sharp raised numerals on the dials. The dimensions of the case are only 7in. long, 4½in. wide and 4⅞in. deep.

The selecting mechanism is simple in design and

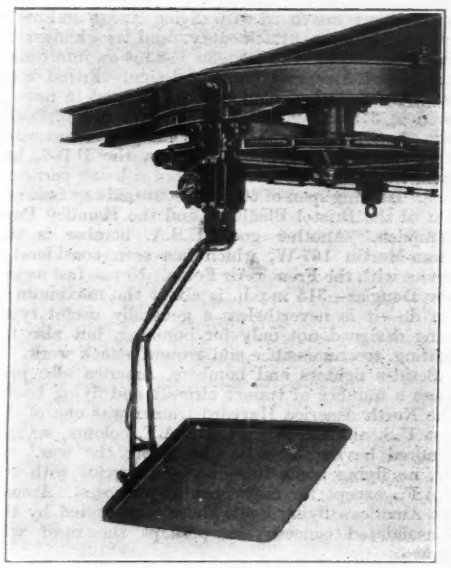


FIG. 2—TRAY TILTED AT DISCHARGE POINT

enables any reasonable number of discharge points to be served. Mounted within the casing (Fig. 3) and extending at one end through the front plate is a rotatable spindle A. At its front or outer end the spindle carries a dialling handle B. Secured to the spindle near its front end is a dial C bearing on its front face numerals corresponding to the discharge stations. Rotation of the spindle causes the numerals on the dial to be brought in succession opposite the window in the front plate. To hold the spindle against accidental movement from the position to which it is moved by the attendant, a disc D is fixed to the spindle inside the casing proper, and a detent E in the form of a spring strip is secured at one end to the casing and at the other end formed to engage in recesses on the periphery of the disc D. Also secured to the spindle is a ratchet wheel F, which is actuated by a toggle pawl, thus returning the spindle to its initial position after the spindle has been actuated by the attendant. The toggle pawl receives its movement from the push rod, previously mentioned, which is depressed by the cam follower engaging the cam on the underside of the conveyor track. The portion of the spindle A at the rear of the ratchet wheel is provided with a screw thread, and on this portion a rotatable sleeve G is freely mounted. On the end of the sleeve G, nearest the ratchet wheel, a cam H is secured having a peripheral portion concentric with and of the same outside radius as the ratchet wheel. Near the back of the case a lever I is secured to the sleeve G. The outer end of the lever is adapted to rest on an abutment in the casing and to this end is secured the Bowden cable which actuates the tipping lever on the tray. The sleeve G is loaded by a spring J, which tends to move the sleeve, together with the cam H and lever I, in a counter clockwise direction to an extent determined by contact of the

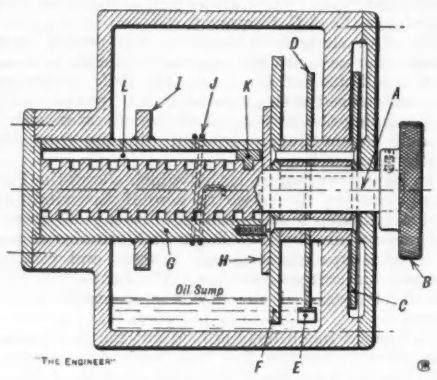


FIG. 3—PRE-SELECTIVE MECHANISM

lever with the abutment in the casing, the spring arranged round the sleeve having its ends secured to the casing and sleeve respectively. For effecting an operative connection between the sleeve G and the spindle A a tee-shaped key K is used, which engages and can slide along the screw thread of the spindle and a keyway L formed in the bore of the sleeve. This member K is arranged in one position to engage a stop on the screwed portion of the spindle so that rotary movement of the spindle in a clockwise direction is accompanied by a corresponding movement of the sleeve and lever.

The actual operation is carried out in the following manner. Assume the mechanism to be in its ineffective condition and that the carrier has been loaded.

The attendant may determine the discharge station at which the carrier is to be automatically unloaded. To do this he rotates the spindle A, by means of a handle, in a counter clockwise direction until the number corresponding to the desired discharge station is shown in the window of the front plate. In turning the spindle from "0" to "1" the stop on the screwed portion of the spindle is moved away from the sliding key, thus allowing the sleeve G to be turned by the action of the spring J until the lever L rests on the abutment in the case. The sleeve G now cannot move any further in a counter clockwise direction. Further movement of the spindle, therefore, causes the sliding key K to be moved along the keyway L by action of the screw to a position determined by the number of turns the spindle requires to cause the selected station numeral to appear before the window. As each successive ramp or cam on the conveyor track is passed the push rod is depressed, thus actuating the toggle pawl and through this paw imparting a unit movement to the ratchet wheel and spindle in a clockwise direction. Owing to the action of the spring J the sleeve G is prevented from moving in a clockwise direction. Therefore the sliding key K is gradually brought back to its initial position and the dial is turned back towards "0." When the carrier has passed the station prior to the selected one the sliding key has been returned until it is now in contact with the stop on the screw. Upon reaching the selected station the push rod is depressed, actuating the toggle pawl which in turn imparts an angular movement to the ratchet wheel and spindle. The stop on the spindle is already in contact with the sliding key, and therefore movement of the stop causes the sliding key to turn in a clockwise direction and thereby actuate the cable and tray tipping lever. This final movement of the spindle turns the dial and "0" appears at the indicator window. The movement of the sleeve brings the cam H into such a position that the ratchet wheel teeth are shielded from the pawl, thus causing any subsequent movement of the pawl to be inoperative until the "Selectatrip" is re-dialled by the attendant.

It is obvious from the foregoing that by extending the length of the screwed portion of the spindle any number of stations can be served without the addition of further parts. The "Selectatrip" at present in production is known as the "Model 99," and, as its name implies, is designed to serve up to ninety-nine discharge stations.

Owing to the position of the ramp immediately beneath the conveyor track, the positive operation of the mechanism is not affected by swing or surge of the carrier. Another special feature of this system, also due to the ramp position, is that discharge stations can be situated at any point along the track, even on any bend or incline.

Canadian Engineering News

Proposed International Bridge

Following a recent conference between representatives of leading New York banking and engineering firms and the St. Lawrence Bridge Commission, it was announced that borings would begin shortly to determine the depth to which supports for the proposed Prescott–Ogdensburg international bridge would have to be carried. A traffic survey also will be undertaken. The estimated cost of the structure is 4,000,000 dols. It is expected that the site of the bridge will be near the centres of the two communities which it is proposed to join, the exact site depending upon engineering studies and cost factors.

Electrical Equipment

A development of particular interest to manufacturers of electrical equipment is the recent announcement that the Canadian Engineering Standards Association is assuming responsibility for the approval of all electrical equipment to be sold or installed in Canada. Under the new procedure every type of electrical apparatus and appliance (industrial and domestic), for sale or installation in any province in the Dominion, may be submitted to the C.E.S.A. for approval, prior to installation or distribution. Each apparatus will be thoroughly tested by a laboratory, appointed for the purpose by the C.E.S.A., and if it conforms to the standard requirements of the Canadian Electrical Code will be labelled with the C.E.S.A. approval seal, to signify that it is considered to be safe for use and contains in its construction no apparent accident or fire hazard. Representatives of the C.E.S.A. will follow up these tests with inspections at electrical plants where the equipment is being manufactured, to assure that such equipment is being constructed according to details of the approved sample. This practice conforms with that adopted by the B.S.I. several years ago. A sub-committee of the C.E.S.A. executive committee, consisting of W. E. Ross, Canadian General Electric Company, Ltd.; Major General A. G. L. McNaughton, National Research Council, and W. P. Dobson, Hydro Electrical Power Commission of Ontario, has been engaged for the past two years in exploring the subject and preparing a procedure whereby a national organisation might unify the work that had been done in the past, principally by the Hydro Electric Power Commission of Ontario, on behalf of all the provinces. The C.E.S.A. recently adopted the recommended procedure and named an administrative board. The administrative office will be situated in the National Research Building at Ottawa.

Big Power Deal

A ready-made market for the major portion of the increased capacity of the Shawinigan Water and Power system which will result from the bringing into production of the new La Tuque plant of the St. Maurice Power Corporation has developed from an agreement reached whereby Shawinigan will supply the Aluminium Company of Canada with 100,000 H.P. for the requirements of its extensive plant additions now under way. The agreement provides for delivery of an additional 25,000 H.P. to the Aluminium Company, if necessary. The St. Maurice power plant at La Tuque, which is being rushed to completion, and from which power will be available in early September of this year, will have an initial capacity of 162,500 H.P. in four units.

Railway Progress

Canadian railway equipment viewed to-day against the background of twenty-five years ago makes a splendid showing, one result of which is the fact that Canadian railways in the past two years have been handling some 30 per cent. more traffic than in 1917—the war peak. Back in 1914, the main lines of most Canadian railways were equipped with 80 lb. and 85 lb. steel rails; to-day the main line standard is from 100 lb. to 130 lb. The largest freight locomotive in 1914 had a tractive effort of 52,000 lb.; the largest Canadian freight locomotive of to-day has a tractive effort of over 90,000 lb. The average freight train of 1914 hauled 350 tons of freight; this has been stepped up to 550 tons. In 1914, the average freight train speed was 10 m.p.h.; to-day it is 17 m.p.h. In 1914 it required 160 lb. of coal burned in a locomotive to haul one thousand tons one mile; to-day it is done with 120 lb. In 1914 it required 11 days for manifest freight to travel from Vancouver to Toronto; to-day the manifest freight service is 7 days. In 1914 the average capacity of a freight car was 33 tons; to-day it is 42 tons. This, taken in conjunction with the much higher speed with which traffic moves, more than offsets the reduction in number of freight cars which has taken place since 1914.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.

New Iron and Steel Prices

The Minister of Supply has made the Control of Iron and Steel (No. 10) Order, which came into force on July 1st, 1940, varying the Control of Iron and Steel (No. 8) Order made on April 4th last. The new Order substitutes a fresh schedule of maximum prices for iron and steel products. The new prices represent additions of from 3s. 6d. to 9s. per ton for pig iron, 22s. 6d. to 27s. 6d. for billets, with corresponding adjustments for other products. These advances are, in the main, to meet from a central fund further abnormal costs of imported materials under present conditions. They also include some allowance for the rises which have taken place in manufacturing costs since the outbreak of war, including recent increases in scrap prices and railway rates. The prices for iron ore, ferro-alloys, and allied materials remain unchanged. For basic pig iron the price has been advanced by 6s. to 8s. 6d. to £5 13s. to £5 15s. 6d., according to district; hematite by 3s. 6d.; foundry and forge by 9s., and Scottish No. 3 foundry by 4s. 9d. Soft untested billets, in 100-ton lots, are now £10 10s.; soft, T.G., up to 0·25 per cent. C, £10 15s.; hard, 0·42 to 0·60 per cent. C, £11 17s. 6d.; silico-manganese, £14 5s., and free cutting, £12 10s. Siemens Martin acid billets are increased by £1 7s. 6d.; tin-plate and sheet bars are now £10 7s. 6d. The prices of manufactured iron have been increased by from 17s. 6d. to £1. Steel joists, angles, plates, boiler plates, and chequer plates have all been advanced by £1 12s. 6d., and medium plates by £1 17s. 6d. Re-rolled angles, tees, and bars are increased by £1 8s. 6d. Galvanised corrugated sheets, 24 G. basis, have been advanced by £1 16s. 3d., and black sheets, 24 G. basis, by £1 17s. 6d.; tin-plates, coke, 20 by 14 basis, are 1s. 3d. higher at 26s.

The Minister of Supply has also issued the Control of Iron and Steel (No. 9) (Scrap) Order, 1940, which revokes all existing acquisition licences under the Control of Iron and Steel (No. 7) (Scrap) Order, 1940, in so far as they apply to scrap iron ingot moulds and scrap iron ingot mould bottom plates. In addition, the Order provides that no person shall treat, use, or consume scrap iron ingot moulds and bottom plates unless licensed to do so or otherwise authorised by the Minister of Supply. The Order also fixes new maximum prices for scrap hematite iron ingot moulds and hematite bottom plates, ranging from £5 12s. 6d. to £6 2s. 6d.

The Pig Iron Market

Although no statistics are available, it is understood that the recent drive to increase the production of pig iron has been successful, and that the position is well in hand. It must not be understood that the output of the blast-furnaces of this country is sufficient to meet the present abnormal requirements of the consuming industries; but the quantities produced are reported to have exceeded expectations and imports to supplement the home output have been arriving on a good scale. Raw materials are in adequate supply, and this has enabled the ironmasters to maintain a satisfactory rate of output. The demand for steel-making iron is, of course, at a very high level, and every ton produced is going immediately into consumption. There may be some tightness in this market, but so far the Control, by carefully supervising the distribution, has kept supplies moving freely to the steel works. The position as regards hematite appears to be growing somewhat tighter, but some of the producers still have stocks upon which they can draw, although these are now at a low level. It is understood that the production of this description will be increased. For the time being consumption is in excess of output, and users' supplies are limited to quantities sufficient only to deal with essential work. The demand is particularly heavy from the Sheffield district. All consumers, however, are obtaining sufficient to maintain their operations. In the foundry department the production of low-phosphoric iron is barely sufficient to meet the needs of the consuming trades, whilst the output of high-phosphoric foundry has been cut down in order to increase the making of basic. Users of both descriptions, however, are finding that they are getting fairly early deliveries if they hold a priority certificate.

The North-East Coast and Yorkshire

All the steel works on the North-East Coast are operating at capacity, and production is reported to be at an unprecedented rate. Practically all the work in hand is on Government account, and it is understood that instructions have been given that orders held by the steel makers which are not essential for the war effort are to be cancelled. The demand for structural steel, heavy as it has been for months, appears to be increasing. All the constructional engineers have big contracts in hand, and their requirements of joists and sections will be on a heavy scale for months to come. Practically all work now undertaken is for war purposes, and although there has been some talk of licences being granted for steel for cinemas, &c., this has become a thing of the past since the distribution scheme has come into effective operation. The demands of the shipyards on the North-East Coast are heavy, but although there have been some delays in deliveries requirements have been met, and considering the intense pressure for steel by all classes of consumers there is little cause for complaint. The position in the plate department is particularly tight, owing to the great pressure to secure material from all the industries using this class of steel. Locomotive builders, tank makers, as well as the shipbuilders, are pressing for deliveries. In Yorkshire the situation is similar to that in other steel-making districts. Works are operating to capacity, but are scarcely able to meet the huge demand for all classes of consumers. Outputs have been increased to the limit, but consumers are still pressing their requirements, both for basic and for acid carbon steel.

Scotland and the North

The output of steel in Scotland has changed somewhat in character as the result of the munitions drive, but there has been no diminution in the volume. A huge tonnage has been produced of various kinds of steel and is passing into almost immediate production. The employers and workmen are working in close co-operation with a view to increasing output, and the efforts to obtain larger deliveries of home-produced scrap are meeting with success. All the shipyards on the Clyde are working full time and their requirements of plates and sections have expanded during the past few weeks. The engineering works in Scotland are operating at capacity and their demands are so large that they are not easily arranged for. Marine engineers are particularly busy and are providing a big outlet for steel materials. The locomotive builders have a considerable number of orders in hand, some on export account; but these have had to give place to the big demand for mechanised Army equipment. The tank makers and boilermakers also are as busy as they can be, and their requirements of plates are so large that some stringency is noticeable in the supply; in fact, if it were not for the careful supervision by the Iron and Steel Control there is no doubt that there would be considerable confusion in the distribution of the various classes of steel. As it is, all orders are carefully scrutinised and the industry is working at practically 100 per cent. on war requirements. In the Lancashire district, also, all the consuming industries are operating to the fullest possible extent upon war work, and the demand for steel has assumed huge proportions. The careful supervision of supplies by the Control, however, has avoided any interference in production through shortage of materials. The demand for sections and steel bars is insistent and there is a continuous request for special and alloy steels. The re-rolling industry is maintaining large deliveries, and in spite of the loss of Continental supplies of semi-finished steel is responsible for a big output. On the North-West Coast the steel works have orders in hand which will keep them employed for months to come, but are concentrating their attention almost entirely upon material required for munitions.

Advice to Contractors

The following advice to contractors has been issued by the Board of Trade:—Government contractors and sub-contractors are urged by the Board of Trade to avoid all unnecessary imports and, at the same time, to assist in speeding up delivery of imports essential for completion of urgent war contracts. Delay in delivery of essential imports, the Board of Trade states, is being caused by failure of contractors to comply promptly and fully with import licensing requirements. This can be remedied by (1) applying for import licences well in advance and not when goods have arrived at ports, (2) sending with applications for licences evidence that goods are essential for a specified Government contract and cannot be bought in this country. Nothing which can be bought at home should be ordered from abroad. The need for avoiding unnecessary importing of goods is greater than ever before because every foot of shipping space and every penny of foreign exchange are required for the immediate war effort.

Copper and Tin

The copper market has not yet recovered from the effects of the French disaster, and there is still considerable uncertainty as to what will happen to some of the contracts previously entered into by the French Government. It is expected that the British Government will take over most of the commitments, at any rate those for which prices have been agreed, but there is some doubt about the remainder. Neutral buying in the United States has practically ceased, since so much of Europe is now in enemy hands or cut off from the United States. The situation in the neutral countries is undoubtedly difficult, and they will apparently have to exist upon what they can get from local supplies. These are not likely to be sufficient to enable them to meet their requirements over a long period. In view of the limitation of the market, it is not surprising that the United States export quotation has dropped to 10.70 c., f.a.s., but at the same time the high freight and insurance charges bring the price to practically the same level as the British quotation. The American domestic price remains at 11.50 c. d/d, but business appears to have fallen off. The rearmament programme is giving a certain amount of support to the market. . . . The most interesting event this week in the tin market has been the announcement by the Colonial Office that as a result of negotiations between representatives of the American Government and representatives appointed by the International Rubber Regulation Committee and the International Tin Committee, agreements have been reached for the purchase by the United States Government organisations of reserve stocks of rubber and tin. A company has been formed for the purpose of purchasing all the available tin as rapidly as possible at a price of 50.50 c. per lb., c.i.f. United States ports, including war risk, with the usual differentials for quality and delivery. It is thought that this move will have the effect of stabilising prices, and that the figure mentioned will become virtually the American maximum quotation. The movements in the tin market previous to this development had been wide. The cancellation of French contracts for English tin resulted in more becoming available for the market and a consequent decline in prices.

Lead and Spelter

The situation as regards lead continues satisfactory in this country. The quantities arriving are apparently sufficient to meet all calls, although these are understood to have increased considerably since the munitions drive started. It has been generally believed that it has not been easy for firms not engaged upon war work to obtain licences, but apparently the situation has improved sufficiently to admit of the use of a certain amount of the metal for ordinary commercial purposes. This may be a consequence of the taking over of French contracts by the British Government. The Associated Lead Manufacturers, Ltd., have circularised a statement which indicates that so far as concerns the materials they produce, lead is obtainable freely. The statement says: "We are informed by the Non-Ferrous Metal Control at Rugby that licences are being granted freely for pig lead for the manufacture of white lead, red lead, sheet, and pipe, &c., but that supplies of copper and zinc are severely restricted excepting for the manufacture of products for service and export requirements. It will be seen from the above that there are ample supplies of lead and manufactured lead goods of all descriptions available for prompt delivery. Merchants' stocks can be sold without licence and all lead products are available from the manufacturers. Wherever possible information should be given with the order as to the use to which the materials are to be put, thus assisting the manufacturers to maintain an adequacy of labour and to obtain licences for their raw materials, packages, &c. There should be no difficulty whatsoever with regard to supplies of lead goods, and wherever difficulty is experienced inquirers are invited to communicate with Associated Lead Manufacturers, Ltd." In the United States the domestic deliveries during May were 47,000 short tons and the production increased to 46,200 tons. At the end of the month the stocks showed a slight reduction to 63,000 tons from 63,500 tons at the end of April. These stocks represented about a fortnight's normal supply to the United States consuming industries. . . . Whilst it is understood that the position of spelter supplies in Great Britain is fairly comfortable, there does not appear to be any surplus for industries not concerned with war work. Before the collapse of France her Government made some important purchases of prompt spelter in the United States, and it has been announced that the British Government will take over any uncompleted part of the contracts. This will lead to considerable shipments to this country and should strengthen the position here. The quantities of spelter received from Empire sources are heavy, but the munitions drive has absorbed unexpectedly large tonnages and it is possible that the additional metal from the United States will be welcomed. The supplies reaching this country from Empire sources consist largely of high-grade metal, and as a consequence firms who would prefer to receive G.O.B. spelter often have to take delivery of higher qualities.

Non-ferrous Metal Prices

The official statement issued by the London Metal Exchange shows that during June values in the tin market continued to rise, resulting in an average quotation for three months tin of £274 9s. 6d., or £12 10s. 6d. above that for the previous month. The average for cash tin was £9 7s. 1d. higher than in May, whilst the settlement price rose by £9 8s. 4d. above the average for May. The statement also includes the official maximum prices for copper, lead, and spelter as fixed by the Controller of Non-Ferrous Metals, and is as follows:—

STANDARD TIN ...	Cash (Mean) £273 12s. 10½d. 3 Months (Mean) £274 9s. 6d. Settlement (Mean) £273 12s.

The following prices for copper, lead, and spelter are the maximum prices fixed by the Controller of Non-Ferrous Metals:—

	£	s.	d.	
STANDARD COPPER ...	—			
Electrolytic Copper ...	62	0	0	delivered buyers' premises
Electrolytic Wire Bars...	62	0	0	,, ,, ,,
Best Selected Copper ...	60	10	0	,, ,, ,,
Lead—Good Soft Pig ...	25	0	0	,, ,, ,,
(Foreign)				(duty paid)
Spelter—G.O.B.	25	15	0	delivered buyers' premises
(Foreign)				(duty paid)

BLINDED MEN AND ENGINEERING WORK.—St. Dunstan's, whose services are exclusively devoted to the welfare of blinded ex-Service men, has secured the active co-operation of influential leaders in industry and commerce in its endeavour to explore the possibility of utilising the services of blinded men in industrial workshops. Among those who have consented to serve on the new St. Dunstan's Research Advisory Committee are Lord Nuffield, representing motor manufacturing interests; Sir Kenneth Lee, representing the textile trades; Lord McGowan, the chemical industries; and Sir Alexander Gibb, the consulting engineers. The primary purpose of the Research Advisory Committee is to secure the entry of experts into the workshops and factories of the larger industries in order to investigate and test the possibilities of blinded men taking their places, either at the workshop bench or machine tools engaged on repetition work. Hitherto, we may recall, the activities of the blinded ex-Service men of the Great War, although varied in character, have not been extended beyond certain of the professions, some business callings, and minor handicraft work. Research records, however, have shown that a blinded man can operate an automatic or semi-automatic machine with dexterity and efficiency. The new Committee has been called into being to investigate the openings for employment in this new field, which, it is felt, blinded men should be allowed to develop. The work of the Research Advisory Committee of St. Dunstan's will be followed with interest.

Rail and Road

WORK TO BE STOPPED ON G.W.R. AND CENTRAL LONDON EXTENSION.—The Ministry of Transport has decided that work on the G.W.R. and Central London railway extension to Ruislip is to be stopped at once, except for rendering safe uncompleted bridges and revetments. This scheme involved the doubling of a part of the G.W.R. line from Ealing westwards with new bridges and embankments. A rolling-stock depot and marshalling yard was to be constructed at Ruislip. Until recently work had been progressing at pre-war speed.

RETURNED EMPTIES BY RAIL.—The railway companies are desirous of making all possible provision for the transport of returned empties in view of the shortage of packing materials. The reuse of packages formerly non-returnable has caused a great increase in the volume of the "returned empty" traffic. It will greatly assist traders to obtain the maximum use of the packages, and will obviate difficulties at goods stations arising from accumulations of empties awaiting delivery if firms will accept delivery of returned empties throughout the day from Monday to Friday, and also on Saturday mornings.

BRIGHTER TRAFFIC LIGHTS BY DAY.—The Minister of Transport has informed highway authorities that where masked traffic light signals cannot easily be seen in daylight they may show either the upper or lower half of the signal face, provided that the signal is fully masked again during darkness. Alternatively, they may retain the 3in. cross throughout the twenty-four hours or show the whole face during daylight. Expenditure incurred in carrying out modifications of this kind will rank for grant from the Road Fund, provided the arrangements have been previously approved by the Minister's Divisonal Road Engineer.

UNATTENDED ROAD VEHICLES.—The Minister of Home Security has made an Order requiring drivers of motor vehicles who leave them unattended to render them temporarily incapable of being driven away. The Order makes it obligatory to lock any unattended vehicle. We understand that a battery master switch, whether concealed or otherwise, is not held to be a sufficient means of complying with the Order, and that a portion of the mechanism must be removed, or a mechanical lock be used. Any policeman or member of the armed Forces, or an L.D.V. may himself put out of action a vehicle whose owner has not complied with the Order.

COLLOIDAL FUEL FOR TRANSPORT.—Scientists of the Research Foundation of Armour Institute of Technology, of Chicago, have been striving to give a mixture of coal and oil a practical application, not only as a motor fuel, but for other purposes, including home heating. Dr. Francis W. Godwin, Director of the Coal Research Division of the Foundation, says that three different types of colloidal fuel have been used successfully in automobile tests. The first of these fuels was a suspension of a specially prepared coal, ground to 300 mesh in a mixture of petrol, fuel oil and lubricating oil. The second test was made with a suspension of the coal in a diesel oil. The third test was made with a suspension of the coal in a very light oil.

FACILITIES FOR TROOPS AT STATIONS.—With reference to the recent criticism in Parliament on the lack of rest and refreshment facilities for troops in many railway stations, the Railway Executive Committee has stated that the railways had since the beginning of the war been making every endeavour to meet the requests of the War Office and welfare organisations for accommodation for canteens and rest rooms at stations. Railway stations were, however, limited in size; most of them were very crowded, and it was essential to keep large areas free for dealing with abnormal war-time requirements. In these conditions it had been difficult, with the best will in the world, to meet all the requests which the railways had received. Measures designed to improve existing conditions had been submitted and were receiving special consideration.

Air and Water

AN AERONAUTICAL RESEARCH SCHOLARSHIP.—It is announced in *Flight* that by the will of Mr. Stanley Spooner, the founder of that journal and *The Auto*, the Royal Aeronautical Society is to receive £5000 for a Stanley Spooner scholarship for aeronautical research.

CANADIAN WARPLANE PRODUCTION.—Production of service aircraft in Canada has now reached a point when 1028 machines can be promised for delivery this year and 1583 in 1941. The personnel of the Canadian Air Force at the beginning of May consisted of about 1389 officers and 10,926 airmen.

INDIAN SHIPBUILDING INDUSTRY EXPANSION.—Plans for the expansion of India's shipbuilding industry include the immediate construction of fifty coastal patrol vessels for the Royal Indian Navy and the building by private enterprise of shipyards for the production of steel vessels ranging from 8000 to 12,000 tons. This programme forms part of the war supply scheme planned by the reconstructed organisation which is controlling the production of more than 90 per cent. of India's war requirements.

MATHEMATICAL SHIPS' LINES.—The Institution of Naval Architects' paper on "Mathematical Ships' Lines," by Mr. F. W. Benson, which is now released for written discussion, describes a method of drawing ships' lines by a mathematical procedure to satisfy previously determined coefficients and characteristics. The lines obtained are, of necessity, perfectly fair, and give precisely the required displacement, coefficients of form, and any other data laid down. Certain hydrostatic curves can be obtained before actually drawing the lines. Equations for the transverse sections are not considered; but the method makes use of a curve of water-plane area coefficients from the keel to the water line. Water-line equations only are used. Proceeding as described, it is possible to adhere to a given water line, a given midship section, and an arbitrarily chosen typical section, either in the fore body or in the after body, and a given sectional area curve. These are the characteristics which, according to a dictum of Froude, largely determine resistance, and it would seem desirable that they should form a basis and be the parameters in the procedure of determining the final form.

ORGANISATION OF PORTS.—Mr. Frank Pick, until recently Vice-Chairman of the London Passenger Transport Board, has begun his new duties as an officer of the Ministry of Transport specially concerned with transport facilities at British ports. He is visiting the ports for the purpose of submitting a report to the Ministry of Transport on the organisation set up to secure the speedy discharge and clearance of goods and thus ensure that any exceptional demands likely to be made on the ports will be met.

BRITISH MINELAYING SUBMARINE MISSING.—An Admiralty announcement states that the minelaying submarine "Grampus" is considerably overdue and must be considered lost. The "Grampus" was completed in March, 1937, at a cost of £408,112, at Chatham Dockyard; she was a sister ship of H.M.S. "Seal," reported missing in May. She had a displacement of 1520 tons and carried a normal complement of fifty-five. Her armament consisted of one 4in. gun, two machine guns and six 21in. torpedo tubes.

CANADIAN DESTROYER SUNK.—It is announced that the Royal Canadian destroyer "Fraser" has been sunk off Bordeaux with the loss of forty-five lives. There were 115 survivors. The vessel was sunk as a result of a collision off the mouth of the Gironde River, while engaged in hazardous duties. "Fraser" was a destroyer of 1375 tons, one of four destroyers of the "Fraser" class, and was built by Vickers-Armstrongs in 1931. Formerly H.M.S. "Crescent," she was acquired from the Royal Navy in 1937. She is the first Canadian ship lost in the war during naval activities.

PROPOSED HIGH-SPEED AMERICAN AIR SERVICE.—It is reported that plans have been prepared by Trans-Canada Air Lines to institute a thirteen-hour service between Vancouver and New York by 1942. The machines to be used are Boeing 307, thirty-three-passenger, pressure-cabin "Stratoliners," which will be able to ascend to considerable heights in winter time to miss storms over the Canadian Rockie mountains. Existing services circle the Great Lakes, but it is anticipated that the new machines will eliminate some 350 miles by being able to fly straight across.

THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS' SCHOLARSHIPS.—It is announced that the Scholarship Selection Committee of the Society of British Aircraft Constructors and the Royal Aeronautical Society have made awards of the Society of British Aircraft Constructors' Scholarships to the following candidates:—Charles Anthony Chapman, Joseph Charles Goodwin, Peter Leland Bertram Graham, Hilary John Silvanus Pinsent, Geoffrey Donovan Poole, and Peter William Wreford-Bush. It may be recalled that these scholarships are designed for the assistance of young men who are unable, for financial reasons, to take up a course of education fitting them to become aircraft engineers.

COLONIAL AIR FLEET.—A Colonial fleet of forty heavy bombers and 160 Spitfire fighters is now ready to take the air. It has been made available to this country by a display of loyalty and generosity on the part of the general public in the Colonies, who in a few weeks have subscribed over £1,600,000. Everything connected with this fleet will, as far as possible, be Colonial. It will have Colonial commanders, and machines will be manned by Colonial pilots and Colonial gunners. The largest single gift in the total of £1,600,000 came from Ceylon. Colonial newspapers from Singapore to Trinidad have raised over £500,000. The funds still continue to grow, and more and more aircraft will be forthcoming to help establish Britain's numerical ascendancy in the skies.

MERCANTILE LOSSES DUE TO ENEMY ACTION.—During the week ended June 16th–17th, the total British tonnage lost was 52,642, but of this figure 5627 tons were lost during combined operations off French ports and are not mercantile losses in the ordinary sense. The figures for this period are accordingly:—British, ten=47,015 tons; Allied, eight=31,574 tons; neutral, six=23,170 tons; total, twenty-four=101,759 tons. German mercantile losses up to June 23rd amount to about 847,000 tons and Italian losses to the same date to about 224,000 tons. Up to Wednesday, June 19th, 25,473 British, Allied and neutral ships have been convoyed in British convoys with a loss of thirty-six ships, giving a loss ratio of one in nearly 708. Neutral ships convoyed totalled 3234 with a loss of three, or one in 1078.

Miscellanea

MAJOR-GENERAL A. E. DAVIDSON.—The War Office announces that His Majesty the King has been pleased to approve of the appointment of Major-General A. E. Davidson, C.B., D.S.O., M.I. Mech. E., as Colonel Commandant, Royal Engineers, with effect from June 3rd, 1940, in succession to Colonel (honorary Major-General) Sir Sydney D'A. Crookshank, K.C.M.G., C.B., C.I.E., D.S.O., M.V.O., retired pay, who has attained the age limit for the appointment.

GOVERNMENT TRAINING CENTRES.—In the House of Commons on Thursday, June 27th, Mr. Ernest Bevin, Minister of Labour, said that civilians in training at Government training centres numbered about 10,700. That was a record and nearly 1000 more than the week before and nearly 2000 more than a fortnight previously. Shift work was being introduced and new centres established, and greatly increased numbers of men for training and instruction were required. The shortage of fully qualified instructors was at present the most serious factor.

TIMBER PRICES RAISED.—Increased prices for imported timber—ranging from 20 to 25 per cent. for expensive hardwoods to more than 100 per cent. for softwoods—have been imposed under the Control of Timber (No. 13) Order, which came into force on July 1st. The Timber Controller, Major A. I. Harris, has stated that the whole of Europe had been cut off as a source of supply. Canada was sending, he said, a tremendous quantity of pit props. By the end of the month 100,000 tons of timber would have been carried by rail from British Columbia to the eastern ports of Canada. He appealed again to dock-workers to speed up their unloading of ships. Home production was steadily increasing, but the biggest limiting factor was scarcity of labour. The Controller added that a special section had been set up to deal with the plywood needed in aircraft manufacture.

BIRMINGHAM ENGINEERING CLASSES.—Free engineering classes have been started at the Birmingham headquarters of Alfred Herbert, Ltd., with a view to preparing unskilled workers, particularly women, for production work in the factory. Each course consists of five lessons. We are informed that Sir Alfred Herbert has been so impressed by the Birmingham scheme that he has given instructions that similar classes should be arranged at his other establishments. He has also passed on the details of the scheme to other firms engaged in machine tool production.

THE LATE SIR RAYMOND UNWIN.—We regret to have to record the death of Sir Raymond Unwin. He died while on a lecture tour in America at the age of seventy-six. An eminent architect and an authority on town planning, he is perhaps best known for his work in connection with the lay-outs of New Earswick Village, near York, for Letchworth Garden City, and for Hampstead Garden Suburb. During the war of 1914–18 he was Director of the Housing Branch of the Ministry of Munitions. He had a combined engineering and architectural training, and in 1923 was made Hon. Doctor of Technical Science of the University of Prague.

THE INSTITUTIONS AND DOMINION EVACUATION.—The Institutions of Civil, Mechanical and Electrical Engineers are in touch with the Engineering Institute of Canada in regard to a proposal from that body whereby members of the three Institutions who are sending their children to Canada for the period of the war, and who have no relatives or friends in that country to whom to send them, might be able to arrange for their children to be received into the homes of Canadian engineers. As the proposal is still under consideration, no particulars can be given at present, but it is hoped to make a further announcement on the subject shortly. A member of one of the Institutions mentioned above, wishing to obtain further particulars of the scheme when available, should communicate with the Secretary of his particular Institution.

DESIGNS FOR SINGLE-STOREY FACTORIES.—In *War-time Building Bulletin*, No. 1, the Building Research Station of the Department of Scientific and Industrial Research put forward economical type designs in steelwork for single-storey, open-shed factories. These, however, are not suitable for exclusive use in factories which require to be camouflaged, and in *War-time Building Bulletin*, No. 4 (H.M. Stationery Office, price 1s.), which has just been issued, the range of roof types has been extended by supplementary designs which, suitably combined with the others in the factory structure, will facilitate camouflage. The principal difference between the two types of structure lies in the roof glazing; in the first case, the glazed areas were placed vertically on the roof trusses, while in the supplementary designs the roof and glazing are sloped, and the roof trusses are symmetrical, of a double-pitched design. The extended range of type designs has been prepared for use by themselves or in conjunction with the original type designs, depending on the camouflage requirements for the factory concerned. Working drawings of the steelwork are available, as before, to those engaged on factories to be erected at the instance of a Government Department, and may be obtained on application to the Iron and Steel Control.

SCHOLARSHIPS IN ENGINEERING.—A leaflet has been issued by the Board of Education announcing the award in 1941 of scholarships and studentships in engineering and other branches of science. A special examination will be held in April, if circumstances permit, and on the result of it twenty Royal scholarships and eleven studentships will be offered. There is no age limit, but all candidates must be British subjects. These awards are tenable at the Imperial College of Science and Technology for courses in engineering, chemistry, physics, biology, geology. Royal scholarships cover the fees for tuition and carry a maintenance allowance up to £100 a year; studentships cover fees only. Whitworth scholarships in mechanical engineering will be awarded on the results of the same examination. The Whitworth scholarships are tenable for three years, and have a minimum value of £150 a year, but this may be increased according to the expenses of the course and the needs of the student. Prizes of £10 each are given to unsuccessful candidates whose performance at the examination appears to deserve recognition. All candidates for Whitworth scholarships must be British subjects. The last day for entry to the examination is January 18th, 1941, and students who are thinking of competing for any of these awards should obtain a copy of the leaflet, form 31A U, from the Secretary, Board of Education, Alexandra House, Kingsway, London, W.C.2

PERSONAL AND BUSINESS ANNOUNCEMENTS

MR. R. BOBLASE MATTHEWS, M.I.E.E., has resigned the chairmanship of Associated Smaller Manufacturers.

MR. D. B. BUTLER has disposed of his practice (both personal and under the title of Henry Faija and Co.) to Messrs. R. H. Harry Stanger, of Broadway House, Tothill Street, Westminster.

THE AIRSCREW COMPANY, Ltd., has transferred its sales department to Grosvenor Gardens House, London, S.W.1. All inquiries for airscrew fans and Jicwood products should be sent to the new address.

INTERNATIONAL AUTO-AERO SPECIALITIES, Ltd., 44, Packington Road, London, W.3, have taken over from Mr. A. Penkuhn, London, W.3, the manufacturing and selling rights for "Artus" milling cutter synthetic resin spacers.

BRITISH JEFFREY-DIAMOND Ltd., Stennard Works, Wakefield, announces that Mr. A. Yorke Saville has been appointed managing director of the company to succeed the late Mr. J. F. I. Thomas. Mr. Saville was formerly chief engineer and was appointed assistant managing director in May, 1940.